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PROCEEDINGS OF THE NINETEENTH COTTONSEED PROCESSING CLINIC

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Held at New Orleans, Louisiana

February 16 and 17, 1970

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE

PREFACE

The Cottonseed Processing Clinic is an annual event sponsored jointly by the Southern Utilization Research and Development Division* and the Mississippi Valley Oilseed Processors Association. Its purpose is to acquaint representatives of the cottonseed industry with current developments in utilization research and to provide for an exchange of information that will benefit industry and future research. Included for discussion in this year's program is a series of panel topics pertaining to oilseed milling problems.

These proceedings report the statements presented by the various speakers during the 1970 Clinic and give an account of the discussions during the three sessions.

C. H. FISHER, Director
Southern Utilization Research
and Development Division

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Norman P. Bartmess

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*As of December 3, 1970, Southern Utilization Research and Development Division changed to Southern Marketing and Nutrition Research Division.

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PROCEEDINGS OF THE NINETEENTH COTTONSEED PROCESSING CLINIC HELD AT NEW ORLEANS, LA., FEBRUARY 16 AND 17, 1970

WELCOME

by

C. H. Fisher, Director
Southern Utilization Research and Development Division
New Orleans, La.

It is again my distinct pleasure and honor to extend greetings to those attending a Cottonseed Processing Clinic. On behalf of the Southern Utilization Research and Development Division (SURDD), I welcome you warmly to this Nineteenth Annual Conference.

It is also a privilege to welcome you on behalf of Fred R. Senti, Deputy Administrator, and Geo. W. Irving, Jr., Administrator, of the Agricultural Research Service. They would like to be present but can't.

Our Program Committee, chaired by Thomas E. Allen and cochaired by Bruno H. Wojcik, has arranged a splendid program. It is clear that we can look forward to having an unusually successful meeting.

Over the years, we have benefited greatly from the invaluable help and friendly cooperation of many individuals and organizations. I wish to express sincere appreciation to everyone who has provided assistance and encouragement in any form. Many friends assist us in different ways:

Our advisers, both official and unofficial, who give us valuable information and suggestions;

The organizations that provide support in the form of funds, fellows, facilities, or supplies; and

Those organizations that help us with evaluations, sometimes on an advanced scale, of new products or processes.

To all of these, we extend our deep appreciation.

I also wish to express gratitude to another group, whose names are on the program. These are the individuals primarily responsible for our meeting arrangements and excellent program. They include:

Officers and members of the Mississippi Valley Oilseed Processors Association, Inc., for our privilege of cosponsoring these annual clinics.

Tom Allen, Bruno Wojcik, and other members of the Program Committee.

General Chairman Norman P. Bartmess, the session chairmen, and speakers.

Dr. Wojcik and his coworkers also deserve special thanks for their success in arranging an excellent clinic.

I hope that all of you will enjoy and profit from your participation in the Clinic and your visit to New Orleans.

OPENING REMARKS

by

G. F. Wallace
The Union Oil Mill, Inc.
West Monroe, La.

On behalf of the Mississippi Valley Oilseed Processors Association, I welcome you to this Nineteenth Cottonseed Processing Clinic.

Cottonseed meal, being a "one market" protein, has been replaced to a great extent in the past few years by urea. But, if we can just linger long enough for the good people at the Southern Regional Research Laboratory, through research, to find other markets for our cottonseed meal, I feel that not only will we survive, but we will prosper.

POTENTIAL FOR COTTONSEED PROTEIN IN HUMAN FOOD

by

D. Rosenfield
Foreign Economic Development Service
U.S. Department of Agriculture
Washington, D. C.

INTRODUCTION

After reviewing the preliminary program for this Nineteenth Cottonseed Processing Clinic, I am certain that subsequent speakers will present more detailed information on the topic assigned to me "Potential For Cottonseed Protein in Human Food." Therefore, I will attempt to set the stage for these distinguished speakers by presenting an overview of the protein food situation which has led many to conclude there is a role for cottonseed protein in meeting the world's needs for human grade protein. This overview will include some thoughts on why the impact of Green or Agricultural Revolution will be long term rather than short term and a discussion of poverty-caused malnutrition in general and protein malnutrition in particular. I will review some of the recent advances in the development and marketing of inexpensive protein foods. And finally, in the context of the possibilities for new protein foods in alleviating poverty-caused protein malnutrition, the potential role for cottonseed protein in human food will be explored.

THE GREEN REVOLUTION

The spectra of widespread famine in the immediate future of developing countries has been postponed, as shown by increases in agricultural production, wherever science and technology has been applied to traditional agriculture. This is being referred to as the Green Revolution by some and as the Agricultural Revolution by others. When adequate supplies of water, fertilizer, pesticides, and modern equipment are coupled with the new high-yield varieties, agricultural production can be doubled and even tripled. But, it is not realistic to expect such increases in food supplies to be readily achieved.

The Green Revolution is still a long way from solving man's problem of adequately feeding the earth's rapidly burgeoning population. For example, the lack of available irrigated land is a constraint to the spread of the high yield varieties. As large financial inputs are needed to construct irrigation facilities, the question may be rhetorically asked: "Where are the poor countries going to get the necessary capital?" Another technological obstacle is the change in texture, flavor, and handling characteristics of the new varieties. For example, the improved high-yielding rice tastes differently; high lysine corn crumbles easily during milling and processing.

It can be concluded that the Green Revolution will spread only at the speed at which the whole process of economic development takes place. There were limited economic advances by developing countries during the 1960's, the so-called "Decade of Development." There is little optimism for sudden, dramatic economic progress during this decade (tables 1 and 2). Thus, the rate of applying science and technology to preharvest agriculture with subsequent improvement in the nutritional status of the majority of poor people in less developed countries will be slow. The Green Revolution is a long term rather than a short term approach.

Table 1. — Comparision between developed and less developed countries in mid-1960's

Item	Developed countries[1/]	Developing countries[1/]
Gross national product (GNP); U.S. dollars per capita	$2,110	$180
Annual growth of GNP — percent —	4.8	4.7
Electric power; kw.-hr per year per capita	3,740	150
Life expectancy-------year--	70	48
Literacy----------percent--	96	38

[1/] Excluding Communist countries.

Table 2. — Projection of economic gulf from the year 1966 to 2000

Country	Population (Millions)		GNP per capita (U.S. dollars)	
	1966	2000	1966	2000
United States	197	318	3,504	10,160
Japan	98	123	919	8,590
U.S.S.R.	233	352	1,288	4,650
West Germany	57	67	1,740	7,790
Brazil	83	212	273	506
UAR	30	79	165	480
India	498	988	84	270
China	710	1,271	98	321
Indonesia	107	239	90	123

Sources: United Nations; U.S. Federal Power Commission; Agency for International Development; "The Year 2000" by H. Kahn and A. J. Wiener; New York Times.

Fortunately, the use of modern science and technology in post-harvest agriculture is increasing in developing countries. By post-harvest agriculture I mean the system of food processing and marketing to bring food, after harvest from the farm and oceans, to the kitchen table. It is here that most of the short term approaches and solutions to alleviating poverty-caused malnutrition are.

POVERTY-CAUSED MALNUTRITION

Perhaps it would be desirable to reflect briefly on this term, "poverty-caused malnutrition". It is widely accepted that the primary cause of malnutrition around the world is poverty. In general, poor people have little choice but to consume a few food staples with monotonous regularity day after day. One measurement of malnutrition due to poverty is the lack of variety of foods found on the kitchen table. A rough correlation can be obtained amongst income, variety of foods, and malnutrition. As money available to a poor family anywhere in the world increases, variety of foods consumed increases and all types of nutrient malnutrition decrease. Another fact of poverty-caused malnutrition is that its occurrence is not necessarily constant. It is dependent upon changing family incomes and food prices. Incomes and food prices may be related to the season. Frequently, the situation is exacerbated in that incomes may go down while food costs go up.

PROTEIN-MALNUTRITION

While there are many types of nutrient malnutrition due to poverty, I believe protein malnutrition is the most prevalent and critical. There is not unanimous agreement on this since protein malnutrition can manifest itself in a variety of ways which are not readily measured or visually observed (clinically detected). Our understanding, today, of protein malnutrition appears to be somewhat analogous to the general feeling about atherosclerosis 20 to 30 years ago. Previously one usually had to have a heart attack to know one's heart was undergoing deterioration. Now blood analysis for cholesterol serves as a most useful early indicator of potential heart trouble. What is needed in the protein area is a biochemical test for the early detection of protein malnutrition, particularly for humans other than infants. This needed indicator would give warning that one is not in a healthy protein nutritional state and is therefore susceptible to other illnesses. Biochemical indices, such as serum albumin levels which are in use today, generally require drastic changes in protein nutrition to be of value. By the time protein malnutrition is clinically evident other diseases may occur which obscure the fact that protein deprivation was the primary cause of sickness. Were more sensitive biochemical indicators available today, I feel the endemic character of protein malnutrition would be more widely recognized. Nevertheless, there is a growing awareness that protein malnutrition can be a problem for people other than special groups such as infants and pregnant and lactating women.

NEW PROTEIN FOODS

The conventional approach to combating protein shortages is to increase the production of both cereal grains and animals. This approach should not be ignored. Since it is closely tied to economic development, it must be a long term solution. Therefore, innovative approaches which can have an immediate beneficial effect on the protein nutrition of large numbers of poor people must be developed and utilized. Within the past few years the processed food industry has begun to assume its logical role in the worldwide attack on protein malnutrition by designing and marketing inexpensive, esthetically attractive protein foods. They may be divided into the following classes:

a. Vegetable mixtures (blended foods)

b. Protein beverages

c. Textured foods

a. Vegetable mixtures. — Vegetable mixtures are designed primarily with nutritional needs in mind. The technology and degree of processing which goes into their preparation is usually less than that found in other protein foods. A major attribute is their low cost. Probably the best known vegetable mixture is Incaparina, a blend of corn and cottonseed protein containing 26 percent total protein. It is fortified with 0.1 percent lysine to increase its biologically utilizable protein. Another representative is CSM which is prepared from 70 percent gelatinized corn, 25 percent soy flour and 5 percent nonfat dry milk. Over one billion pounds of this 20 percent protein has been distributed around the world under the U.S. Food for Peace Program.

b. Protein beverages. — New protein beverages have great potential for popular acceptance as beverages appeal to all segments of a society. Protein beverages may be divided into two groups: milk types and those that resemble soft drink beverages. The technology for their preparation is similar. Packaging and method for marketing to the consumer are generally the major differences. There is special interest in developing countries in stretching their meager fresh milk supplies without lowering nutritional value. One way is the addition of protein concentrates from sources such as dry skim milk or other protein concentrates such as peanuts, soy, or cottonseed. This technique is referred to as "toning." In India there is much interest and activity in the toning of high fat buffalo milk, and acceptance of milk types and toned milks is dependent, in part, on the advances in developing and technology for preparing stable suspensions of protein and fat and the addition of appropriate flavors.

Soft drink protein beverages vary in nutrition, appearance, and flavor. To be commercially successful in the market, they must first give refreshment to the consumer. Their nutritional contributions are generally secondary from the standpoint of purchase. Vitasoy, which is being successfully marketed in Hong Kong, is one example of this kind of beverage. It contains about 3 percent soybean protein, 20 percent of its calories are from protein and its cost is 3.5 U.S. cents per bottle. Another example is Puma which has exceeded all market expectations since its introduction by Monsanto in Guyana. Current plans call for the introduction of Puma, which is patterned after the Vitasoy model, into other countries. Coca-Cola is marketing a caramel flavored protein beverage in Brazil. It is expected that a number of carbonated protein beverages will be market tested in the near future. P. Ballantine and Sons is currently testing a prototype product in the United States. The protein beverages are now selling at the same price as competitive soft drinks. When they replace regular soft drinks in the diet, the added nutrition is at no extra cost.

c. Textured foods. — One way to increase the use of new protein foods is to build texture into erstwhile food powders. For example, wide use of wheat as a human food is due to its ability to be made into the textured products bread and noodles. Wheat flour, per se, is not consumed. The development of new textured protein foods represents a dramatic advance in the evolution of protein foods from low-cost sources such as oilseeds, fish, and petroleum. While today, the major textured vegetable foods are prepared with soybeans, the technological principles for use are similar for proteins from fish, petroleum, and oilseeds other than soy. The availability and use of these materials will evolve to meet the special economic and nutritional situations in developed and developing countries. We can expect to see more fabricated foods prepared from both animal and vegetable sources. This may be done to lower cost or it may be done for functional reasons. For example, many food dinners now appearing in the U.S. marketplace contain meat particles prepared from beef and isolated soy protein. Such products rehydrate upon cooking to a more desirable texture than an air-dried all meat particle.

In summary, the increasing twin demands for convenience foods and lower-cost foods will surely increase the opportunity for problem solving by extending textured meat foods with protein from nonanimal sources.

POTENTIAL FOR COTTONSEED PROTEIN

In the context of the foregoing remarks, it is appropriate to consider the potential for edible cottonseed protein. As previously noted, soy protein dominates other oilseed proteins in human food use. This is largely because the technology for converting soy protein to esthetically appealing food products is the most advanced. Also, more is known of soy protein's basic chemical and

physical properties and this fundamental knowledge has been applied to food product development. Cottonseed and peanuts are frequently mentioned as logical protein alternatives to soy in foods. But, it must be emphasized there is no inevitability to their use. Additional research and development and, perhaps even more importantly, creative marketing nerve are needed if the maximum potential of cottonseed and peanuts is to be realized.

In addition to competition from soy and peanuts, cottonseed faces competition from other sources such as coconuts, sesame, and safflower.

No discussion of additional protein sources would be complete without mention of fish protein concentrate (FPC). While FPC may not be the panacea its proponents make it out to be, there is no reason to assume that it will go away. Quite the contrary; its use will increase as the technology of FPC production improves (with subsequent lowering of costs) and more is learned about food product applications. Other sources, such as single-cell protein and leaf protein, may yet have a role to play in human foods. At the very least, these sources can have an indirect effect if they are used in animal feeds as substitutes for oilseed protein meals. Parenthetically, the use of these substitute proteins in animal feeds may accelerate the development of human foods from cottonseed proteins.

Two recent developments can pave the way for a meaningful contribution by cottonseed protein in the human diet. These are (1) the discovery of glandless varieties of cottonseed which are gossypol free and (2) the development of a process for separating the intact pigment glands, which contain gossypol, from the oil and protein portions of cottonseed. In this process, the residue (marc) from the solvent extraction operation is fractionated in liquid cyclone equipment into a human-grade fraction which is 65 percent protein and is relatively free from gossypol. The remainder, which is 70 to 80 percent protein, goes for animal feed. This separating process was originally developed here in New Orleans by the Southern Utilization Research and Development Division of the USDA Agricultural Research Service. Dorr-Oliver, the manufacturer of the liquid Cyclone is currently producing (under large-scale pilot plant conditions in India) degossypolized, nonheat-damaged protein and is working with local food firms to develop food uses.

The glandless variety of cottonseed negates the need for fractionation. However, before there is a changeover from glanded to glandless varieties, the problem of preserving yield and quality of the cotton lint, the major economic component of the cotton crop, will have to be solved. Many in a better position to know than I have stated that this obstacle will be overcome within this decade and that future cotton crops will be of the glandless variety.

Another important factor which should lead to increased use of cottonseed as a low-cost, edible protein is its presence in areas of the world where soybeans, its current principal competition, are not grown. A rationale for oilseed protein use follows. (See also table 3.)

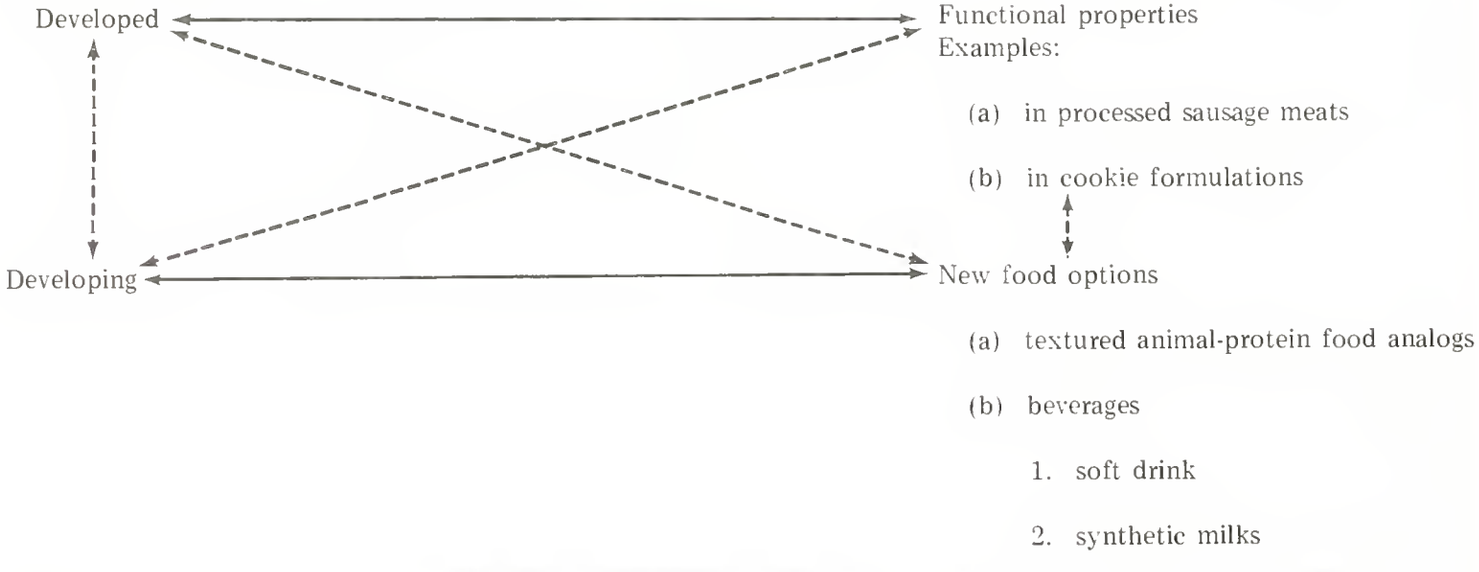


Table 3. — Agency for International Development protein food programs

Region or country	Company	Date of contract	Product	Raw materials
El Salvador	Pillsbury	February 1967	Protein beverage powder; comes in three popular flavors	Sesame seed, wheat germ, sugar.
Brazil	Krause Milling	March 1967	Traditional food, "fuba" fortified with soya	Corn, soya.
Brazil	Swift	April 1967	Milklike beverage dry mix Textured soy protein in sausage-type food	Soya, nonfat dry milk.
Brazil	Monsanto	June 1967	Soya beverage bottled as soft drink	Soya, sugar.
Tunisia	International Milling	May 1967	Traditional staple food 'cous-cous,' fortified with high-protein wheat fractions	Wheat.
India	Dorr-Oliver	December 1967	Cottonseed protein concentrate practically free of gossypol; flour can be an ingredient of human foods	Cottonseed.
Kenya	Del Monte	June 1968	Beverage	Soya or other oilseed proteins.
Pakistan	General Mills	do	Textured oilseed protein products or sauces	Soya/cottonseed.
Thailand	Archer Daniels Midland	August 1968	Textured soy protein foods	Soya.
India	Swift	July 1968	Similar to their Brazilian project	Soya, cottonseed.
Guatemala	General Mills	June 1969	Fortified tortilla mix	Soya, corn.
Dominican Republic	Lee Wilson & Co.	do	Extruded cereal-protein food	Peanut, corn.

The business considerations of General Mills, the manufacturers of the commercially successful product Bac-Os, illustrates this point. General Mills is studying in Pakistan the use of meatlike particles in local kabob dishes. The meat analogs are prepared from meat and soy protein. If their testing shows market acceptance of the meat-soy kabob, there is an economic necessity to use cottonseed protein in place of soy protein to go commercially onstream. Cotton is available in Pakistan and soy is not. Thus, the economics of any commercial operation dictate the use of cottonseed protein.

CONCLUDING OBSERVATIONS

Any conclusions as to the future for human use of cottonseed protein must be made with reference to other nonanimal protein sources in general and oilseed proteins in particular. A good barometer for the future of these sources can be found in the recent past. Prior to the mid-1960's, there were a number of isolated efforts to utilize oilseed proteins in human foods. These were small from a commercial point of view. There was little business incentive to develop foods containing oilseeds. The rationale behind any effort was usually the desire to improve protein nutrition. But, animal feed demands generally took precedence over the world's human nutritional needs. We have witnessed in recent years the increasing use of oilseed proteins for their functional characteristics, nutritional properties, and low-cost compared to animal protein sources in both developing and developed countries. There is every reason to believe this use will accelerate at an increasing rate in the next few years. The social and economic pressures which have led to significant usage, coupled with available supply and advances in technology, virtually guarantee this.

In the scheme of things to come, the role of cottonseed protein instead of other nonanimal sources will, in the final analysis, be determined by the usual laws of supply and demand. There is and will be the demand for human-grade cottonseed protein; whether or not there will be adequate supplies will depend on the various industries represented by many of you in the audience today.

DISCUSSION

QUESTION: I was curious to know just how much nutritional value was in one of the drinks like "Puma." How many calories — I don't know if this is how to express it.

DR. ROSENFIELD: We express its protein nutritional value in two ways: (1) As percent protein, and (2) as percent calories supplied by protein. Puma is 7 percent protein; Saci 3 percent protein or roughly one gram of protein per ounce of drink. The percentage of protein from calories in Puma and Saci is 19.5 and 14.6 percent, respectively. These beverages have more of their calories from protein than human milk.

QUESTION: How would you compare what a child, say in some of these countries, could get from one bottle with a normal daily intake?

DR. ROSENFIELD: I can answer that question at various levels. Let's say a child does drink one bottle a day. He is now getting 6 grams of additional protein. Obviously, if that's all he's getting, he'll die. However, if he is on the borderline of adequate protein nutrition this amount could put him over the top. This is really the way to look at this. These drinks are not medicines designed to meet all caloric and vitamin needs, but are rather a way to get extra protein to a child who might otherwise not get it. The extra protein could make all the difference in the world for marginal cases.

QUESTION: You say the fourth meal. Is this something close to a fourth of what they are getting, the people who are generally considered to be undernourished from malnutrition?

DR. ROSENFIELD: There is a philosophical issue here. Are you trying to develop a food or are you trying to develop a medicine? If you are trying to develop a medicine, goodness knows "Puma" or "Saci" are not the answer. On the other hand, in a poor country, if we can direct the child to picking a refreshing drink and give added nutrition at no extra cost, we are doing him a benefit. That's the name of the game.

QUESTION: I notice on your chart the per capita is $180. At 10 cents a gallon — for this fourth meal — can they afford it?

DR. ROSENFIELD: Well, the point is they do now. They are buying soft drinks regardless of whether they can afford to. I was in a village in Sudan where I was offered a "Fanta" orange drink by poor people. In our own country you will find cases of soft drinks in the dwellings of really poor people. It's not a question of affording it since they are now using some of their cash for soft drinks. If we can supply nutrition at no extra cost, we are making a contribution. We are not necessarily saying they should be buying soft drinks, but for 10 cents a poor person can enjoy an item which people financially better off also enjoy. In a sense, he becomes "as good" as the next guy. You don't need to be a Ph.D. in psychology to appreciate this fact.

QUESTION: You did not mention cottonseed protein. Is it being eliminated?

DR. ROSENFIELD: I must have slipped. It's in my text.

QUESTION: It's still being used?

DR. ROSENFIELD: Yes.

FOOD PROTEINS – AN OVERVIEW

by

R. E. Martin
Swift Chemical Company
Oak Brook, Ill.

Before discussing food proteins specifically, let's examine, in general, some of the factors that are causing our subject matter to be of such domestic and international concern.

Any living and growing organism, be it human, animal, or vegetable is a chemical entity needing calories to operate, proteins, vitamins, and minerals to build, expand, and maintain good finished product quality.

World population approximates 3.5 billion and is currently growing at 2 percent per year. At this rate, world population by 1980 could be 4.5 billion and possibly reach 6 billion by the year 2000.

FACTOR ONE, THEREFORE, IS PEOPLE, sheer mass numbers of people.

Nutritionists estimate that an average male in the United States needs about 70 grams of protein per day, the female 58 grams, and children between 32 and 85 grams.

Using 60 to 75 grams as a per capita figure for world population, the protein demand is:

	1967	1980	2000
PROTEIN DEMAND, 10^6 TONS	77-96	104-130	145-181
POPULATION	3.2×10^9	4.3×10^9	6.0×10^9
PROTEIN GAP, 10^6 TONS		2.34 of animal protein 1.45 of legume type protein 5.0 of cereal or grain protein	

It is also estimated that 23 to 31 percent of the total proteins consumed should be of animal origin. At present, the proteins that are being consumed consist of approximately 67 percent from plant origins, 25 percent from meat and milk, 5 percent from poultry, and eggs, and 5 percent from fish.

FACTOR TWO IS A PROTEIN GAP

It must be understood that most of the problem areas are in South America, Central America, Africa, Asia and India. By 1970, more than 70 percent of the world's population will be living in these areas, and by 1980 the figure will climb to 75 percent.

This gap can be illustrated another way as represented by the following multitude of factors:

- Population growth
- Changing eating habits
- Ability to buy – income
- Arable land development
- Yields per acre
- Productivity per worker
- Mother nature
- Distribution channels
- Politics and wars
- Crop varieties
- New food sources – soy, fish, petroprotein, others
- International monetary
- Policies
- Land regulation

Some of these factors can be controlled and managed. Others, of course, cannot.

It does look like world population will increase faster than the world's estimated ability to grow food.

One of those factors that can be managed is the subject of this paper – Food Proteins – as new food sources.

A readily abundant source of protein by crop size is soybeans, over a billion bushel harvest.

As each new year passes, we hear more and more about soy finding yet another use for human consumption, some of what we hear in this respect has been reported with a certain amount of fear attached to it. Why?

Because that small golden bean has vegetable, fruit, dairy, meat, and doughlike properties. It has the potential to imitate some foods, but rarely to completely replace them.

Soy protein is a food ingredient, a helpmate to the entire spectra of the food processing industry.

All of the meat, dairy and other traditional foods we enjoy today, and that industry can produce in the future will be consumed. by whom and at what price remains the bigger question. Certain segments of any future population will always be able to afford the best of natural products. As populations increase and certain food-stuffs become more expensive, lower segments of society will turn to less expensive products that best resemble traditional foods. These will contain soy.

WHO/FAO/UNICEF[1/] — Protein Advisory Group News Bullet in No. 6 relates the relative cost of protein from selected raw material sources.

	Protein cost per pound
Beef (retail)	$4.44
Chicken (dressed)	1.50
Wheat (flour)	.60
Bulgar wheat	.47
Peanut meal (defatted)	.43
Dry skim milk	.40
Wheat (whole)	.30
Cottonseed flour	.17
Fish meal (feed)	.14
Soy flour (food)	.11

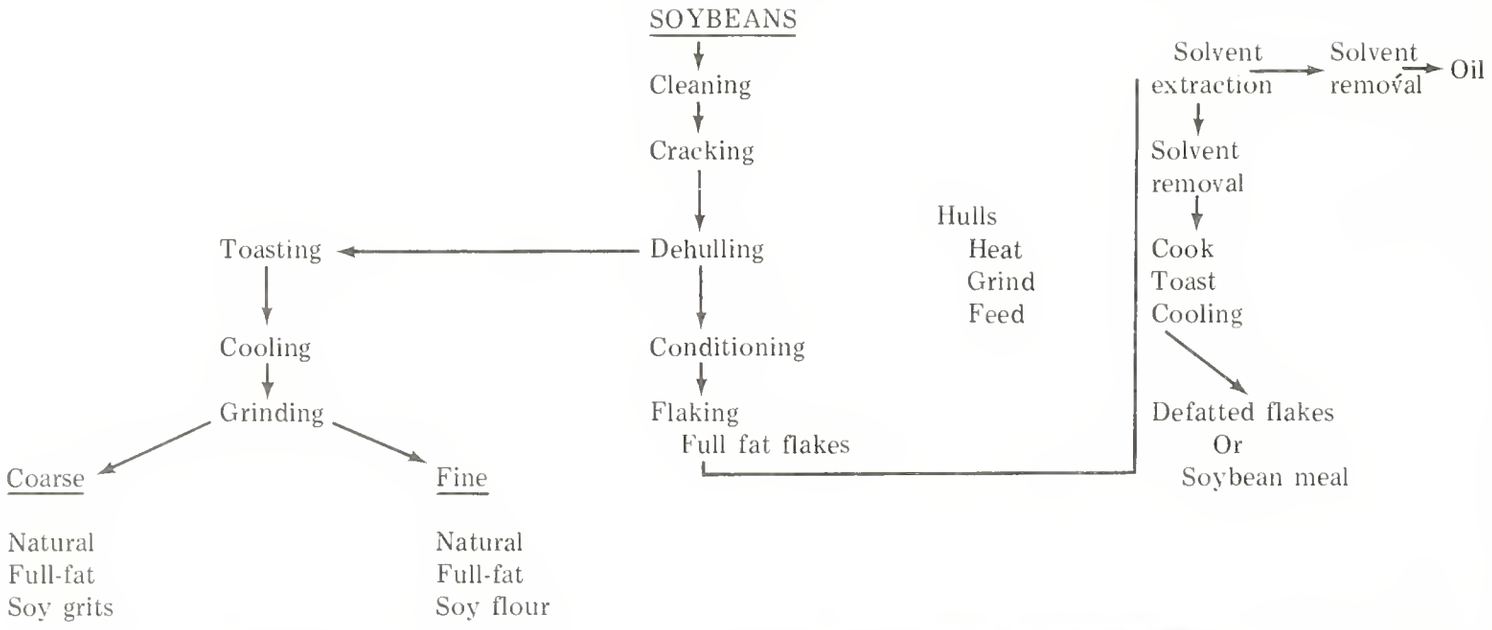
Because soy has exceptional chemical and physical properties, the consumer can expect to see their wider use in traditional foods and a very definite planned use in new product introductions.

Let me briefly develop how that bean has progressed to the position we find it in today.

Cultivated in the Orient for many centuries, we find soybeans introduced in the United States in 1804. Then for more than 100 years that bean and what it held remained nothing more than a laboratory curiosity. In 1915 the crop was so insignificant that we find no record of it by the USDA.

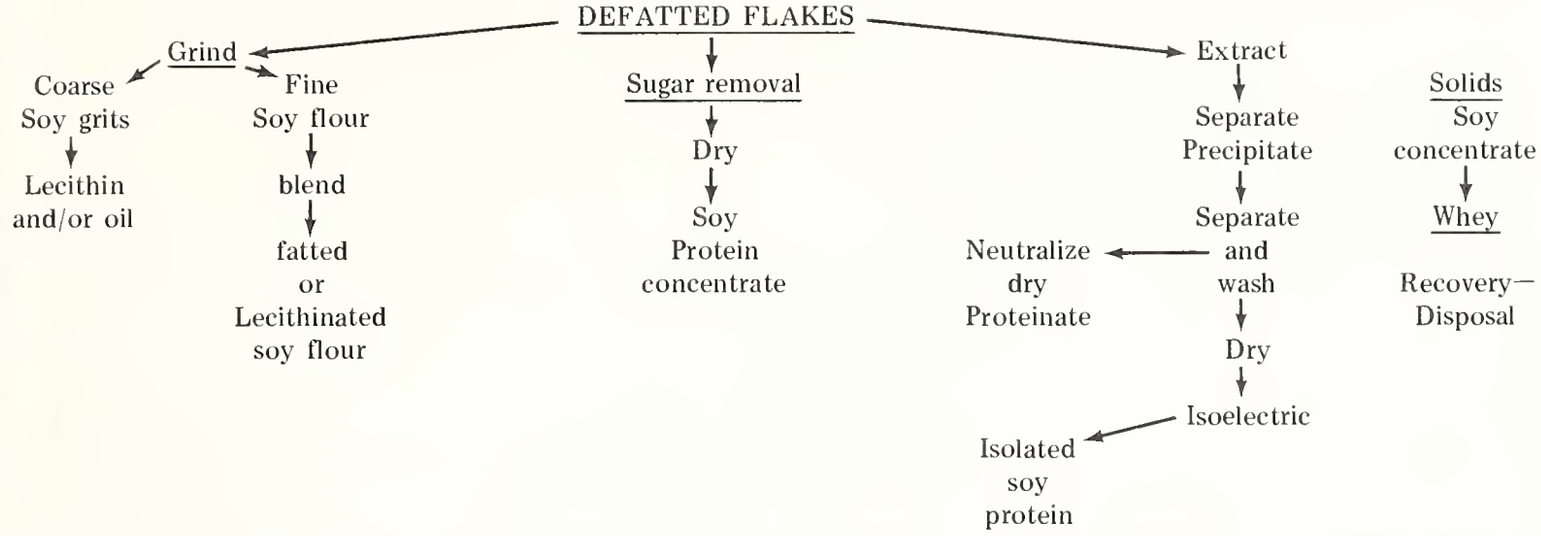
The first commercial attempt to use soy for edible purposes began in the late 1920's with the introduction of soy flour and grits.

The following flow chart shows the processing steps necessary to prepare our basic raw material — soybean meal.



After oil extraction, and when the solvent is removed by low heat or vacuum, a protein retaining its functional properties is produced, namely defatted 50 percent soy grits or flour. This flour, grit, or meal then becomes a base for either further extract protein or for the development of texture.

[1/] World Health Organization/Feed and Agriculture Organization of the United Nations/United Nations Children's Fund.



Used as conventional edible flours, these products and their many variations can be found today as an ingredient in doughnuts, specialty breads and rolls, milk replacers, both meat and cereal baby foods, ground and sausage meat products, pasta products, pet foods, and many war on hunger formulations.

The size of this market is approximately 300 million pounds annually excluding the above-mentioned government formulas. One hundred million of this volume is pet food oriented.

We next find isolated soy protein commercially introduced in 1946. This product characterized by its 90-percent protein content is the purest commercial form of soy protein available. The isolates are quite unique as food ingredients because they can emulsify, thicken, gel, form films, and whip.

The candy, cereal, baking, edible coating, meat, oriental food, beverage, snack, soup, topping, dessert, dip, and spread markets enjoy the use of isolated soy protein.

Nineteen hundred and sixty saw the introduction of the 70-percent soy protein concentrate. The concentrates can be prepared by extracting defatted soybean meal with suitable polar solvents that will remove the more soluble carbohydrate but retain the protein. For example, if a 50-percent protein meal is extracted with alcohol, very little protein is solubilized while most of the carbohydrates, flavor, and color bodies are removed. A typical concentrate composition follows:

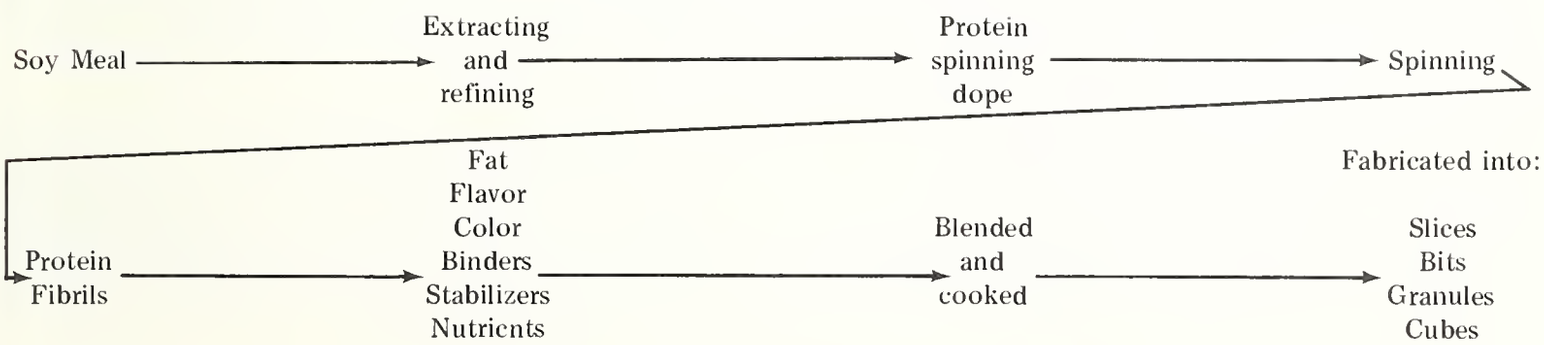
	Percent
Protein	70
Available carbohydrates	15
Mineral (Ash)	3
Crude fiber	5
Fat	2
Moisture	5

Sold principally to the meat patty, sausage, and cereal industries, these concentrates have the ability to bind water and fat exceptionally well without compromising the overall nutritional makeup of the final product. This same concentrate was responsible for the success that certain diet products enjoyed several years ago. They carried enough protein into a formula to make it significant. They were bland and flatulence free.

Originally precipitated by Henry Ford's curiosity, spun protein fibers have been the subject of much controversy since the middle forties.

The first significant breakthrough was made by Robert Boyer who produced a fiber by a process similar to that used for textile fibers.

SPUN FIBER MANUFACTURE



Basically, defatted flakes or flour are extracted and purified to an isolate. This pure protein is dispersed in alkali and then precipitated at the isoelectric point in a bath by drawing it away continuously from the face of spinnerets to form tiny monofilaments. These fibrils are combined with such other ingredients as wheat gluten, egg albumen, vegetable or animal fats, flavors, and colors. The mixture is then cooked, which sets up a mass-like structure.

Such typically engineered products have compositions like:

3-percent ash	2-percent ash	3-percent ash	2-percent ash
17-percent carbohydrate	58-percent fat	61-percent fat	48-percent fat
20-percent fat			
60-percent protein	40-percent protein	36-percent protein	49-percent protein
Ready-to-eat spun fibers unflavored	Beef (raw)	Medium fat pork (raw)	Chicken (raw)
			Dry basis

Commercially introduced in 1963 the product that resembles spun textile fibers does imitate meat very closely. However, even the spun protein fiber is but one ingredient in a complex mixture of many components. It is used in the building of a new food family concept. Their biggest drawback is high costs to produce and low yields from starting raw material. Results to date show very limited use.

The newest family of soy proteins introduced in 1966 are such that I call them textured. Their technology is quite new and little of a specific nature is known about it. These textured proteins are much more economical to produce than spun fibers. Their function:

FLAVOR — Compatible with most food systems
Adaptable to variety of uses
Stable at ordinary temperatures

TEXTURE — Remains crisp when dry
Fibrous and chewy when hydrated
Maintains shape and texture during cooking and retorting and during storage of cooked or retorted products

Increases retention of natural flavors, juices, fat, and moisture.

As ingredients compare favorably with that of the spun products in most applications.

PHYSICAL PROPERTIES OF TEXTURED SOY PROTEIN

TEXTURE: Crunchy when dry
Fibrous and chewy when hydrated
Particles retain their integrity during cooking

COLOR: Light tan, or colored to meet a specific need

FLAVOR: Slightly toasted or flavored to meet specific needs

HYDRATION: Weight fully hydrated is equal to 3.5 times the dry weight.

One prime example, the baconlike material made from this process has been one that has been most readily adapted to date. It is seen as an ingredient day in peanut butter, salad dressings, and as a she stable consumer product by itself.

Here is an example of a concept, new and unique, fulfilling a purpose that real pre-fried and crumbled bacon could not.

We have engineered soy protein to fit specific needs, giving the food technologist a better tool for new product development. I have never before seen a soy product that holds as much promise for developing new food ideas as that which the textured varieties offer.

What is more significant than all the remarks made thus far is the fact that new commercial developments in soy utilization are coming at a faster and closer rate to one another.

It took 20 years to go from an edible soy flour to an isolate; 15 years from the isolate to the concentrate; 3 years from the concentrate to the spun fibers and another 3 years to the new textured soy protein. A great deal awaits us around the corner for we have just begun to unlock and understand proteins.

Consider also that, as we have developed our history, 95 percent of what has been used as edible soy has been as food ingredients, helps to other food processors, not hindrances or substitutes.

We now turn our attention briefly to cottonseed protein. This potential protein source is just beginning to emerge from a pilot plant basis. Its commercial edible development was held back until now because of a gossypol problem. Gossypol is the toxic alkaloid found in the glands of regular cottonseed.

It is my estimate that it will take another 2 to 4 years before any sizable new glandless cottonseed crop is available to process on a commercial basis. Glandless cottonseeds will provide a direct source of new proteinaceous material with some rather unusual chemical and physical properties.

In addition to the normal processing that the new crop material will receive there exists another method, experimental, at the moment, that should be mentioned. This later process does not depend upon glandless seed, however. Called the Liquid-Cyclone-Process (LCP), it involves the mechanical separation into two fractions of specially ground, oil-free cottonseed kernels in a hexane slurry.

Experimental runs indicate that each 100 tons of cottonseed should yield about 36,000 pounds of high quality flour containing 65 percent protein. On this basis the United States alone could produce some 2 million tons of such flow annually, and the rest of the world another 6 million tons.

Separation is achieved by running this slurry under pressure into a cone-shaped device known as a liquid cyclone.

Spinning or whirling the liquid or slurry produces a centrifugal effect throwing the heavy meal particles outward and downward to be drawn off the bottom while the fine particles are forced to the center and upward to be drawn off the top.

The larger and most desirable fraction contains about 65 percent protein. When finely ground into flour, it has a bland flavor and light creamy color. The smaller fraction containing virtually all the gossypol pigment glands and fiber would go into normal cottonseed meal markets such as animal feeds.

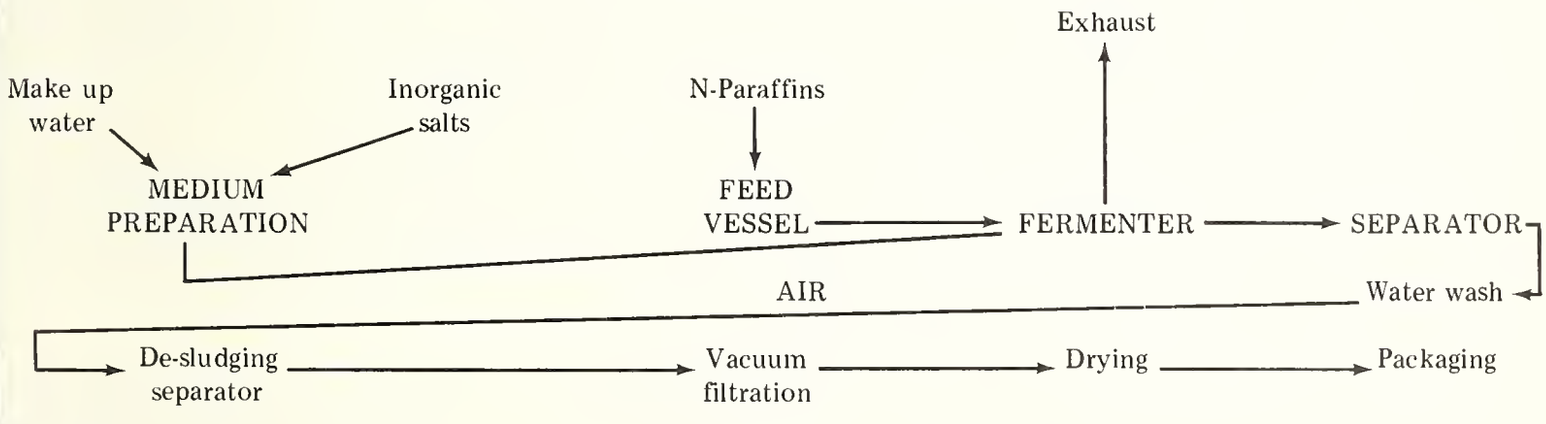
Present edible cottonseed prices range from 10 to 12 cents per pound.

Since proteins contain the elements carbon, hydrogen, oxygen, and nitrogen and petroleum and natural gas contain only carbon and hydrogen — oxygen and nitrogen have to be combined with petroleum to produce what we know as petroprotein.

The large companies involved in this research grow yeast continuously on straight chain paraffinic hydrocarbons in water containing ammonia, phosphates, and potassium. Oxygen is supplied by air circulation.

This same type microbiological conversion could use bacteria, but yeasts are preferred because of fewer processing problems.

Schematically a continuous single-cell, protein-production process using petroleum looks like:



Yield claims range from 80 to 100 percent (dry yeast), considerable heat is involved, and a large amount of water is needed. Oxygen requirements are approximately 1 pound per 1 pound of yeast produced. Maximum yields were obtained using the C_{15}-C_{19} normal paraffins.

Roughly calculated, a 50-ton per day plant would cost approximately 2.5 million dollars and produce a feed grade 50 percent protein for 5 to 7 cents per pound. That price does not reflect any selling, advertising or administrative expense.

It has been estimated that to produce an edible petroprotein product, the cost per pound of protein could be as high as 35 cents. This cost increase reflects additional processing necessary to reduce flavor, odor, and color problems.

U.S. companies actively engaged in this research include Esso, Nestle, Phillips, Standard-Indiana, Gulf, Standard-New Jersey, Socony, and Chevron.

Markets, raw materials, technology, economics, competitive factors and timing, while they are all still uncertainties, are apparently going in favorable directions for petroproteins. Animal feed uses may not be more than a few years away in some areas of the world. Direct food uses seem much further off.

Amino acid supplements may be needed for methionine, tryptophane, cystine and isoleucine. Petroproteins seem sufficient in lysine, which wheat and other cereals are not. Lysine is essential for growth in both humans and animals. The petroproteins are also high in vitamin growth factors.

Fish protein is another source of consideration.

The development of FDA approval of a commercial method for producing fish protein has a twofold significance:

1. For world malnutrition problem solving
2. For domestic economic benefit to the U.S. fishing industry

The development of FPC is really the development of an entirely new means of preserving fish, but in a different form. This concept can utilize most species of fish that heretofore have not been commercially sought because they had neither yield nor economic advantages to the fishing industry. At present, less than 20 percent of the potential four- to five-thousand-billion-pound worldwide supply of fish is being utilized.

Last May, the Agency for International Development granted the first commercial contract for FPC production under its Food-For-Freedom Program. The agency ordered $900,000 worth of products from Alpine Marine Protein Industries, Incorporated, New Bedford, Mass. This plant has a 40,000 pound per day capacity, and is licensed to use the Vio Bin process developed by Ezra Levin of Monticello, Ill. It is anticipated that the price range for this FPC order is 42 to 50 cents per pound.

In contrast to the Vio Bin process, the Bureau of Commercial Fisheries has been working on another process using isopropyl alcohol, and to date has had limited success.

Oceanic Development Corporation of Houston, Tex., is also constructing a plant in Peru to continuously process an FPC suitable for human consumption, again under the Vio Bin License.

Uses developed to date find FPC as a food ingredient of potential value in bread, macaroni, noodles, soups, and confections.

Problems remain in economics, processing, and flavor, but the Government is confident that these will be overcome in the future.

World-wide developments in protein based foods include:

Monsanto's Puma — A soft drink for the South American market

Corn Products — Cerealine--low cost, cereal-like, high protein food for Brazil

Coca Cola's — Saci--A chocolate based soy beverage for Brazil

Quaker Oats — Incaparine--cereal-like protein product for Central American market

Hind Brothers — Pro-Nutro--cereal-like protein product for South Africa

Many more are under development.

Other protein sources are also being investigated. They include algae, blood, leaf, mushroom, peanut, sesame, sunflower, and safflower.

Reflect for a moment that the U.S. Government has purchased under its Food For Peace-Blended Food Product Program, over one billion pounds of CSM (Corn-soy-milk) mix. Twenty percent of that volume was soy flour.

In conclusion, then, we find soy protein in predominance because it is readily available, there is sufficient crop size, yields are excellent, and processing experience has reduced their production to a profit making venture.

Compare the following yields:

COMMODITY	AVERAGE YIELD PER ACRE	LBS. PROTEIN PER ACRE
Soybean	24.2 Bu.	508
Other legumes	20.7 Bu.	293
Corn	64.1 Bu.	323
Wheat	25.1 Bu.	180
Milk	2,780 Lbs.	97
Beef	342 Lbs.	58

What develops in the future will depend on how the above factors are managed and how the pressure of world demands dictate future needs.

DISCUSSION

QUESTION: On the situation that is opposed, what might be considered unsuccessful acceptance of fishmeal protein? I understand that the objection by our Government was that it had such a high fluoride content. Is there any hope of being able to curb this situation?

MR. MARTIN: I think so, it's long range again. This fluoride problem is not as big as it's made out to be. The biggest problem is flavor. Really, chemically and technically the fluoride problem can be overcome. It needs some more work, however.

QUESTION: The source of fluoride in a fishmeal product, what is it? Is it essentially from the bone structure?

MR. MARTIN: That's right.

QUESTION: This could be separated?

MR. MARTIN: It could be, but again for edible uses the cost goes up when you add another step in the processing.

QUESTION: How many months a year would you be able to operate a fish protein concentrate plant?

MR. MARTIN: Depending on where it was located. In this country, you're somewhat limited, of course. But in the southern waters, you should be able to use it all year round.

COMMENT: In reference to the fluoride content, I know that in Seattle as well as in Canada they are using a mechanical device called "deboners," which is a Japanese machine which does a very good job at very low cost. I think this fluoride problem could be solved short term.

MR. MARTIN: Consider, too, that what really will have to happen if this is going to be a commercially feasible, economic material to use, is that some type of deboning system will have to be developed for an on-the-ocean ship.

QUESTION: If we took gossypol in cottonseed flour down to 0.04 percent free gossypol and total gossypol was in the range of 0.25 to 0.30 percent, if this were considered to be toxic to humans particularly when it was included as a supplemental ingredient in the over-all volume of a finished product, do you consider this a serious matter?

MR. MARTIN: I do not.

ECONOMIC OUTLOOK FOR U.S. COTTON

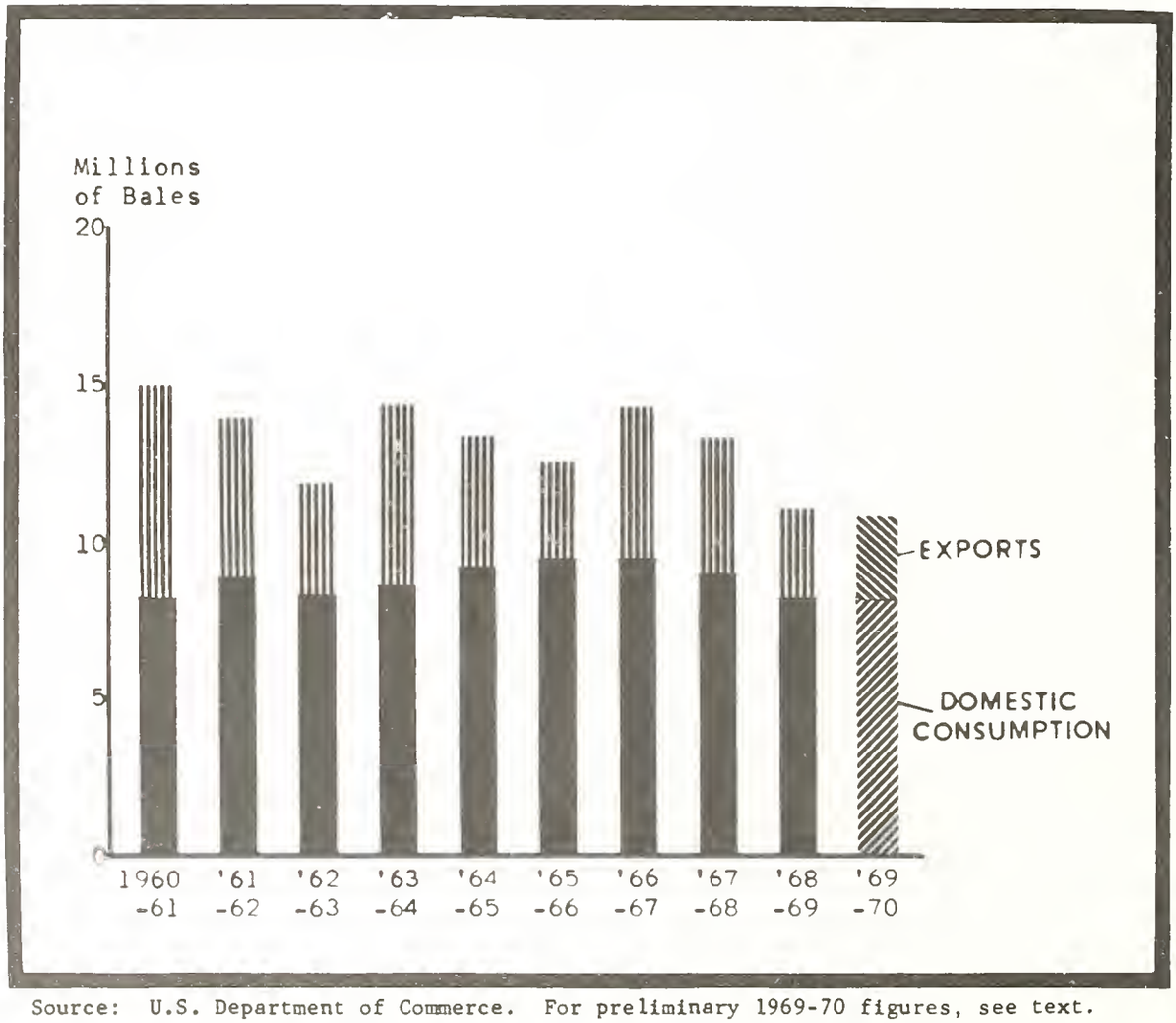
by

C. W. Russell
National Cotton Council of America
Memphis, Tenn.

The pace of competitive losses for U.S. cotton slowed down to a walk in 1969. There were emerging signs that in the next season a higher export demand might lift the size of the total market. The chances for any lasting market improvement are put in question, however, by increasing problems of production.

The record of the U.S. cotton offtake in the decade of the 1960's is summarized in figure 1. This includes a preliminary indication for the crop year 1969-70, which ends next August 1. Consumption by domestic spinning mills is projected at the actual rate experienced in the first five months through December, with seasonal adjustment. This rate is 8.2 million bales.

For exports we are using the figure shown by the U.S. Department of Agriculture in its revised estimates of just a few days ago. This is 2-1/2 million bales. While this is a very low figure by past standards, there is some skepticism in the trade about exports going even this high. The skepticism is reinforced by the fact that actual exports through the first five months, as reported by the Bureau of the Census, were only 755,000 bales. The Department itself qualifies its 2 1/2 million bale projection by saying exports "likely will not exceed" this figure. There is always a wide range of possible error at this time of year, but the Department does have considerable data to support 2 1/2 million as the center of probability.



Source: U.S. Department of Commerce. For preliminary 1969-70 figures, see text.

Figure 1. — U.S. cotton offtake.

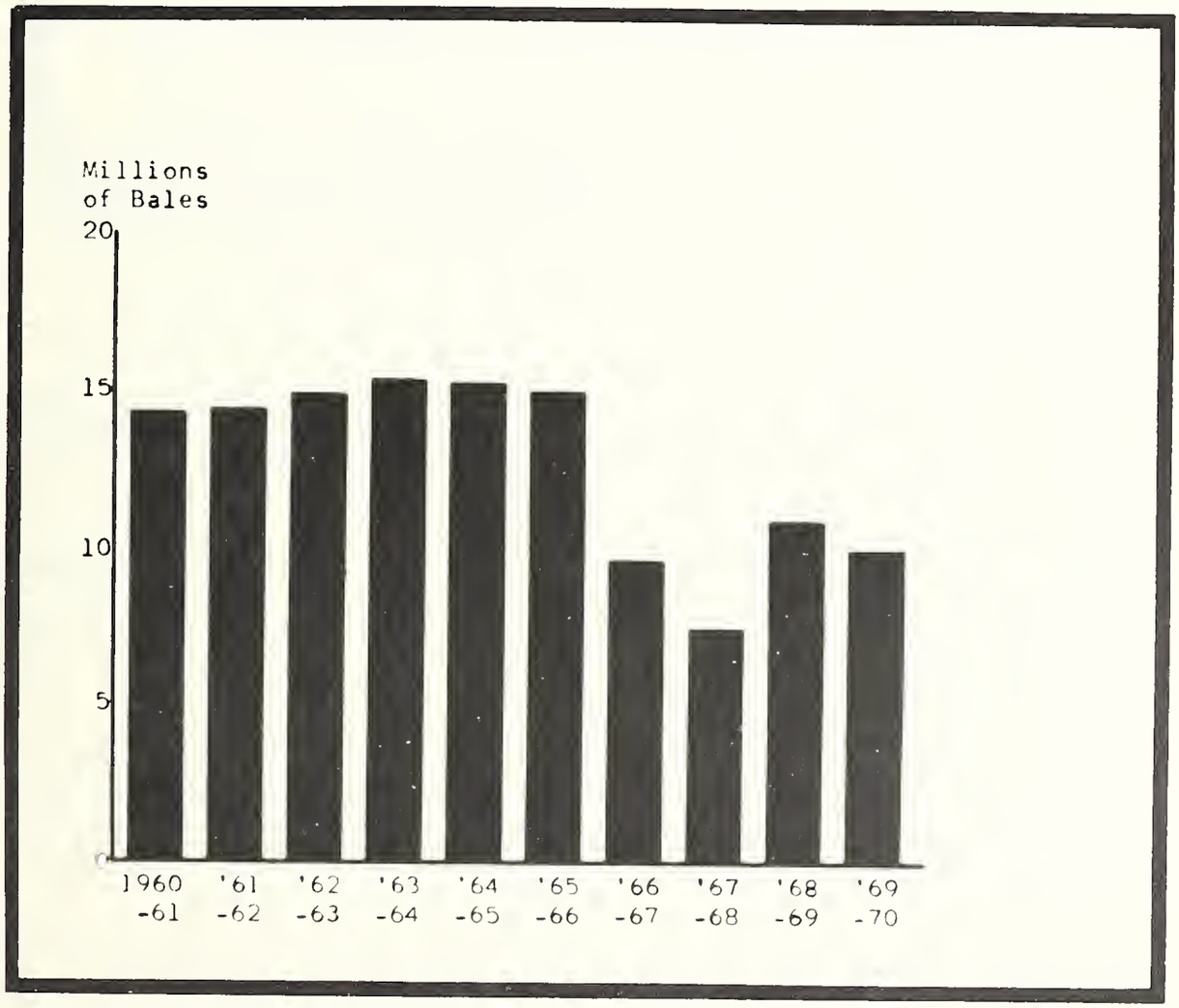
If these indications are correct, the offtake in 1969-70 total about 10.7 million bales.

The astounding record of cotton production in the decade of the 1960's is shown in figure 2. Down through the crop of 1965, it held consistently to a level of 14 or 15 million bales. But the crop was only 9.6 million bales in 1966 and 7.4 million in 1967. It rose to a mere 10.9 million in 1968. Now for the crop of 1969, we find that the ginning report for the period through January 15, 1970 was only 9,826,000. Total production evidently will wind up at about 9.9 million. We have to go back to the 19th century to find four straight years of production as low as these.

The outlines of these same bars for production are shown in figure 3, and the record of the offtake is superimposed upon them, so that the production and offtake for each crop year can be compared. Figure 3 also has a curve showing the year-to-year changes in the August 1 carryover. The carryover changes are governed largely by the difference between the production and the offtake (although raw cotton imports, the "city crop," and a year-end adjustment are relatively minor factors).

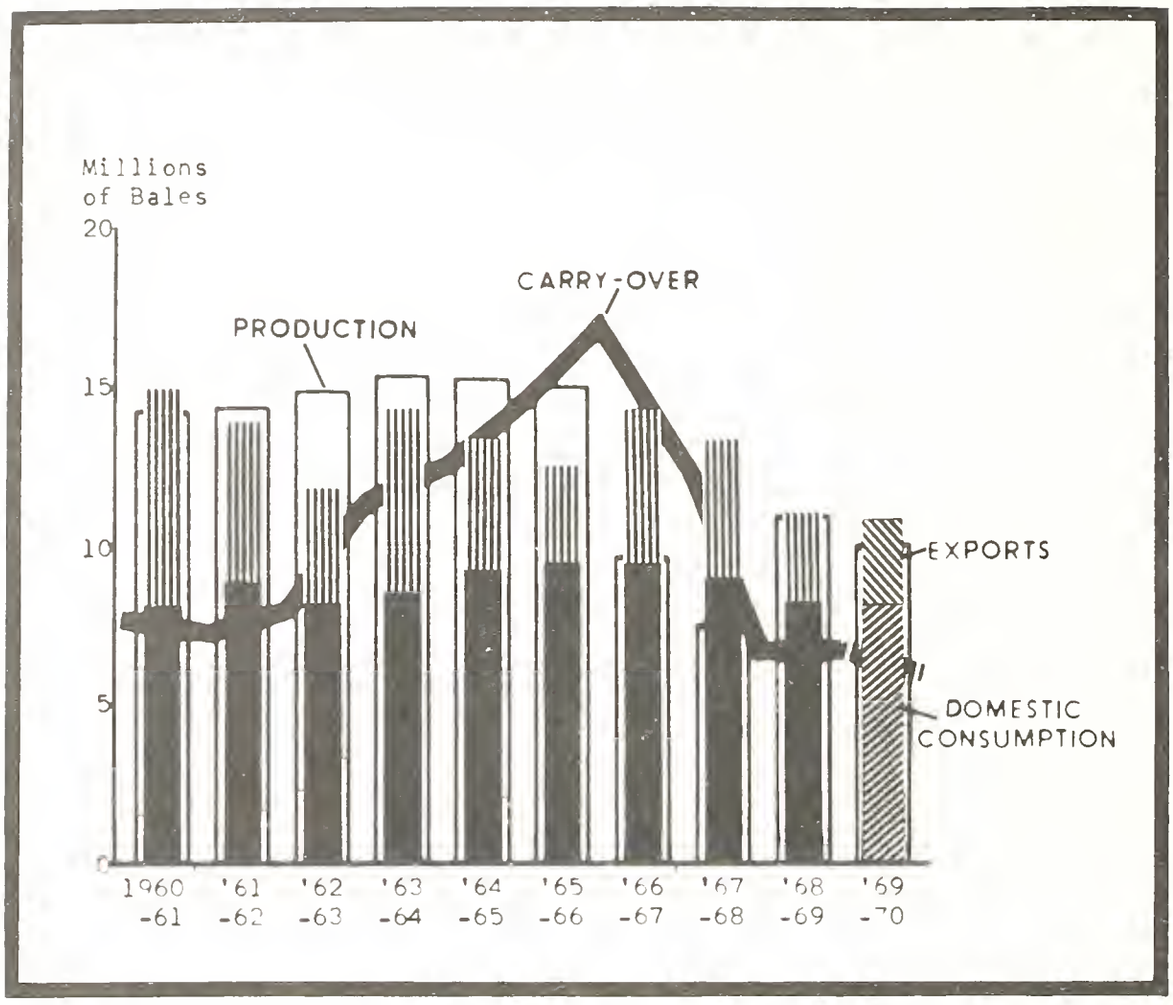
Production exceeded the offtake for five straight crop years, from 1961-62 through 1965-66, and the carryover rose sharply. Then the tragically short crops of 1966 and 1967 eliminated all the surplus and seriously damaged the markets for cotton in the process. The reduction of the carryover in a two-year period was more than the increase in the previous five years. Last season (1968-69) the small crop was about equal to the small market, so that the carryover held about even at 6-1/2 million bales. Now this season, if we should actually market 10.7 million bales, even that would exceed the amount produced by some 800,000, and the carryover next August 1 would be a little below 6 million.

It could be argued that 6 million bales are plenty of carryover for the needs of a 10.7 million bale market, but it would be dangerous to stop there. We must go on and ask whether the production next season will be fully as much as next season's domestic consumption and exports. There is a very good chance that the offtake in 1970-71 will rise well above the 10.7 million bale level, and there is no assurance that production will rise from this year's 9.9 million to the full amount of next year's offtake. There is a serious risk that inadequate production will bring new damage to our market, reminiscent of 1967.



Source: U.S. Department of Commerce. For preliminary 1969-70 figure, see text.

Figure 2. — U.S. cotton production.



Source: U.S. Department of Commerce. For preliminary 1969-70 figures, see text.

Figure 3. — U.S. cotton.

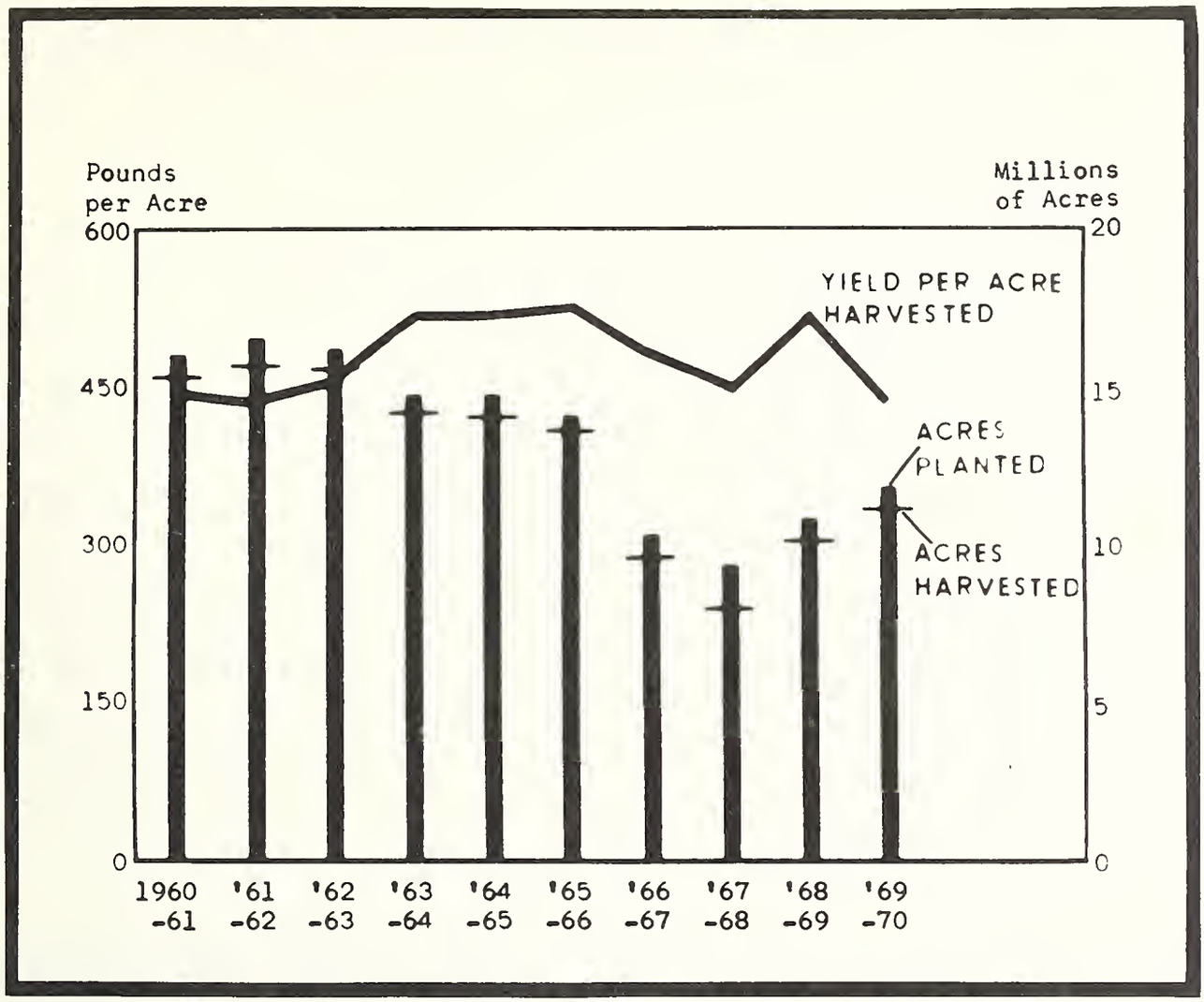
The hope of this struggling industry to get back on its feet is overshadowed now by uncertainty and doubt as to whether it will produce an adequate supply of cotton under the economic and political circumstances that it will face, not only in 1970 but (even more seriously) in the years beyond 1970, when some new government program will probably be in effect. The question whether producers will have adequate incentive to grow cotton moves into the forefront of our problems.

Acreage and yield. — The four small crops which we have had under the Food and Agriculture Act of 1965 deserve further attention. The big dropoff in production was the combined result of disappointing yields and of surprising low cotton acreages.

Both of these factors are reflected in figure 4. Notice first the curve representing the average yield per harvested acre in the Cotton Belt as a whole. The strong upward trend of yields, which had done so much for the cotton economy over a long period of years, seemed to begin losing some force after 1963. From 1965 on, the main direction has been downward. The indicated average yield for the 1969 crop as a whole is 436 pounds or less — the lowest since 1957.

Apparently bad weather is the main explanation, but there have been other influences as well. By now it seems fairly obvious that one of them has been the use of "projected yields" as the basis for government payments. If only a part of a producer's income in a given season is related to what he actually produces, and the rest is paid to him regardless of how much he spends on producing a good yield, he obviously has a reduced incentive to spend heavily on production, especially in a time of high costs and low cotton prices like the present.

Now look at the vertical bars in figure 4, giving the record of total cotton acreage across the same 10 years. The top of each bar is the number of acres planted. The cross marks set off in the upper portions the number of acres abandoned. The length of bar below each mark shows the number of acres harvested.



Source: U.S. Department of Agriculture. Figures for 1969-70 are preliminary.

Figure 4. — U.S. cotton.

The acreage reductions in the first 2 years of the 1965 Act (i.e., in 1966 and 1967) were even steeper than the reductions in yield. In 1968 a good rise in yield accompanied a 2.2 million advance in the number of harvested acres, so that production rose from 7.4 to 10.9 million bales. Then the crop of 1969 declined a million bales because the drop in yields was greater than the rise in acreage.

The acreage which farmers decided to plant in 1969 was watched with extreme interest because it was the first time that there were no diversion payments under the Act of 1965. The previous year, farmers could not plant more than 65 percent of their allotments without sacrificing a payment of 6 cents a pound on projected yields. And in no case could they go above 95 percent of their allotments without losing all their payments. This year, both those features were removed, so that we had a relatively clear-cut test of what farmers would plant on their optional acres for the return that they could expect to get from the market or the loan. And in that light the increase was disturbingly small. It was only about a million planted acres and 900,000 harvested acres.

Table 1 may give some insight into the planting decisions for the crop just nearing completion and for the one just ahead. The original allotment for the 1969 crop was 16.2 million acres, but from that we must subtract about one million acres which were removed by various government programs mentioned in the table. In addition there were some 200,000 acres which farmers did not elect to enroll in the program. There was left a balance of about 15 million acres on which farmers signed up for participation. On these acres the producers definitely had to make decisions whether to plant them to cotton or not. They decided not to plant about 3.2 million acres.

Table 1. — Allotments and planting of cotton acreage (in thousands of acres)[1]

Allotments	1969-70	1970-71
Original allotments	16,200	17,150
Productivity adjustment under sale and lease of allotments (plus approximation of other small adjustments such as for acres released but not reapportioned)	600	630 (?)
Approximate acreage under various land retirement programs	400	320 (?)
Available allotments (approximate)	15,200	16,200 (?)
Available acres not enrolled in program (approximate)	200	200 (?)
Acreage enrolled in program (approximate)	15,000	16,000 (?)
Plantings	11,797	?
Acres enrolled but not planted (approximate)	3,203	?

[1] Source: Allotments and plantings are from U.S. Department of Agriculture. All other figures are round estimates based on unpublished data of the Department.

Plantings in 1970 and beyond. — For the planting season just ahead, the Department of Agriculture has recognized the need for more production by raising the total allotment a million acres. After some reduction in the small farms reserve, the total allotment will actually increase by about 950,000 acres, to 17,150,000. The other figures shown in table 1 for 1970-71 are quite conjectural, but we are including them as a basis for consideration, and we have flagged them with question marks to signify that they are no more than reasonable guesses. If these guesses are correct, there will be an increase of about one million in the number of acres enrolled in the program — from 15 million last year to 16 million this year.

How much increase will this actually bring in the 1970 plantings?

The magazine, Cotton Farming, recently surveyed 1,200 producers for their 1970 planting intentions. It used the same selection pattern which had proved to be accurate within less than one percent the previous season. The results indicated that total plantings in 1970 will increase only by 343,000 acres.

The magazine, American Cotton Grower, also conducted an extensive survey in the various sections of the Belt and found that planting intentions indicated an actual drop of 414,000 acres in the total.

The Cotton Council, through its area field supervisors, recently interviewed a small number of substantial and efficient producers in each section of the Belt. The primary purpose was to ask whether there was much likelihood that growers would go even above 100 percent of their allotments in later years, if given the opportunity to do so with no incentive other than the return to be expected from market prices. We did not find indications that many producers would do this. But in the course of these interviews we did find an impressive number of good producers who were thinking of planting a smaller percentage of their allotments even this year (1970) than the year before.

Some of the main considerations affecting planting decisions in 1970 will be these:

(1) The increase of a million acres in the allotments is an important plus factor. But most of the other leading influences that we can think of will tend to discourage plantings on the acres that get no payments.

(2) Market prices on most cotton are down considerably from a year ago. Prices received by farmers for cotton this December averaged 160 points below those of the previous December.

(3) Prices of some alternative crops are up. Corn and grain sorghum are well above last year. While soybean prices were down this fall from a year earlier, they were well above the levels that might have been expected at planting time. They held generally above the reduced loan level.

(4) The U.S. Department of Agriculture has not provided a broad summary of cotton production costs since 1966. For that year the Belt-wide average cost was reported to be 26.6 cents, including overhead. The behavior of prices and wages since that time suggests strongly that the average cost is up quite a few cents from that figure today. Certainly the producers themselves testify that it is up substantially.

(5) Even if the cost and return figures for a particular farm do show cotton to be the most profitable crop this does not mean that cotton will be planted. The total cash required to produce an acre of cotton is much higher than for most alternatives. Therefore, the risks tend to be greater and the problem of getting finances is much greater. The combination of tight money and a series of poor crops has made financing a critical problem. It is clear that many farmers this season cannot get financed for more than their domestic allotments.

(6) Producers are now deeply concerned about the kind of program that must be adopted in the months ahead for the years after 1970. With the future in doubt, they hesitate to make capital investments which are necessary to get adequate production even in 1970. They are told that, among other things, the Department of Agriculture leans toward a reduction of 2 cents or thereabouts in the support price. And they are told that many authorities on the mood of Congress see payment limitations as inevitable, although the Cotton Council and many other groups are fighting as hard as they possibly can to prevent limitations.

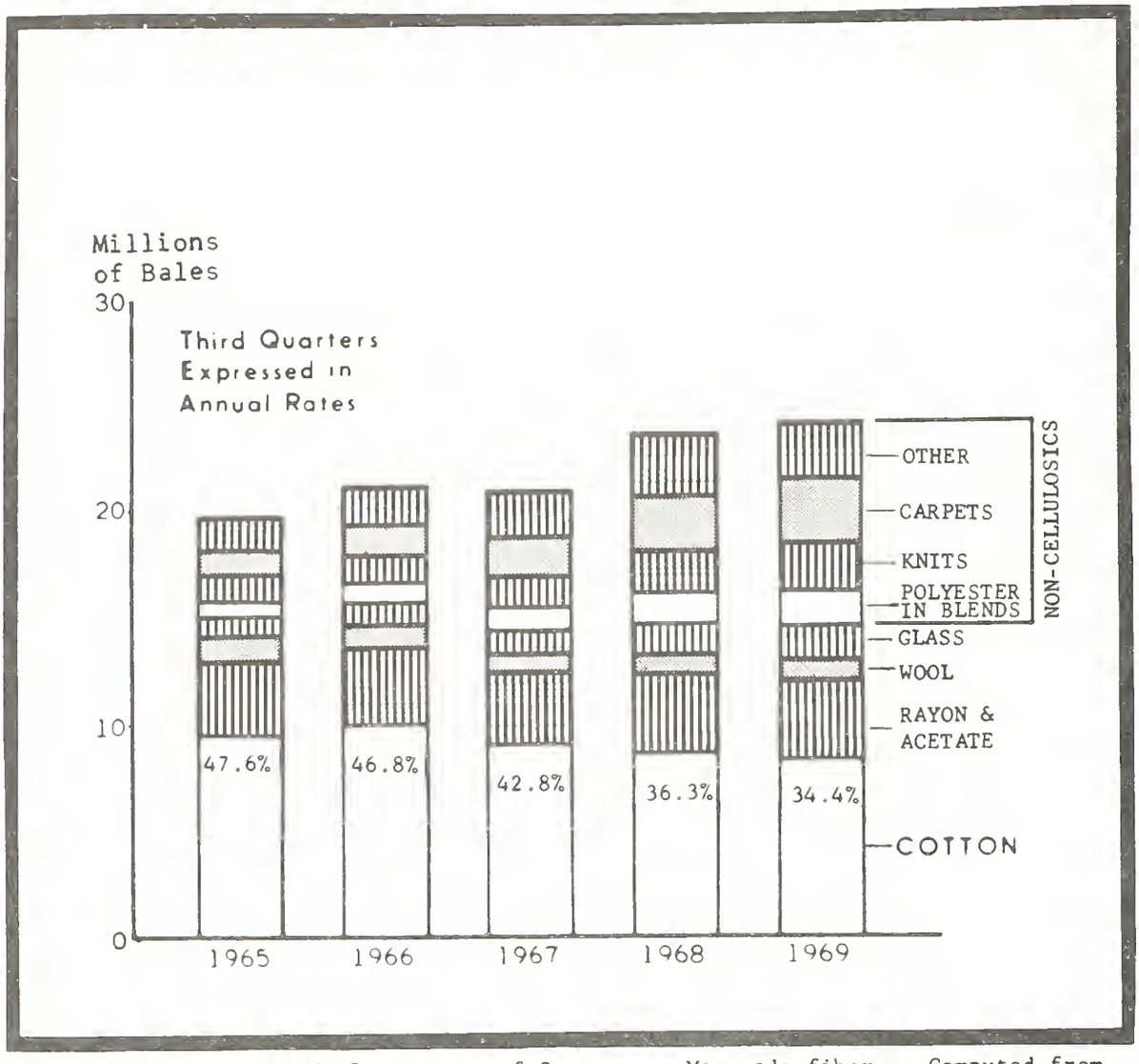
We have never heard a sound economic argument in favor of limitations. So far as we can tell there is none. The merits of the whole farm program are at least arguable; but if the program is to be accepted at all, there is no sound argument for destroying the larger producers with limitations. Few things could be more inflationary or could do more damage to the consumer or to the productivity and progress of this country. But we are told that in the arena of politics all this is now irrelevant. If the limitations advocates think at all about the economics of cotton, they appear to make the assumption that somehow the larger producers are immune to the costs of production and, therefore, can do very well without payments.

These reasons for concern about the size of future crops come at a time when the carryover is the lowest since 1953 and when the current crop and the current market are in a kind of uneasy balance at a low level. All past experience tells us that production and the market are not going to stay very long in this close relationship. Inevitably we shall see a big difference appear — one way or the other. We might get excellent growing weather in 1970, for a change. If this happens and the market stays as low as it is now, we might have plenty of cotton for a while. But there is at least an equal chance that low plantings and poor or mediocre weather will be coupled with some upward turn in the market. If this happens, we will have a much more genuine squeeze on the supply than we experienced in 1967. No one can be sure about the one season just ahead; but if we continue indefinitely with policies that perpetuate this gamble, it becomes almost certain that sometime, before many years have passed, we shall have another supply squeeze reminiscent of 1967 and another blow to our expert and domestic markets which could wipe out a great deal of what is left. If we intend to compete with the steady, assured supplies of synthetic fiber in today's market, there has to be more assurance of the adequate cotton supply.

All fibers in the domestic industry. — We switch now to an analysis of cotton's performance in the domestic textile market. Cotton's competition is not limited to textile fibers, but at this point we shall consider all such fibers which move through our domestic textile industry, including those which are manufactured as filament yarns by the synthetic companies and those which are spun on the wool system. A broad summary of all such domestic consumption is attempted in figure 5. The only item omitted is tire cord. (The additional problem of import competition from foreign-made textiles will be treated in a later section.)

Since some of the essential figures are not available for the fourth quarter at the time of this report, we are showing in figure 5 the record for the third quarter of each year. The figures are seasonally adjusted and are plotted in terms of the annual consumption rates. Again all the fibers are crudely converted into equivalent bales of cotton.

Notice cotton's portion of the total, as it appears in the lower part of each bar. The actual level of cotton consumption dropped from an 8 1/2 million annual bale rate in the third quarter of 1968 to an 8 1/4 million rate in the same quarter of 1969. But this occurred across a period of time when the growth of all textile operations was rather slow. The tragic competitive loss had been a year earlier, following the 1967 price binge, when the total domestic market rose 2.6 million bales, and cotton's dropped 400,000. Cotton lost 6 1/2 percent of the entire market (from 42.8 to 36.3 perent) in one year.



Sources: Cotton -- U.S. Department of Commerce. Man-made fiber -- Computed from data of Textile Economics Bureau and U.S. Department of Commerce with use of U.S. Department of Agriculture factors for conversion to equivalent cotton bales. Tire cord is excluded. Non-cellulosics in polyester blends, knits, and carpets -- Estimates based primarily on Department of Commerce data. Wool -- Department of Commerce data converted to cotton equivalent on pound-for-pound basis.

Figure 5. — Fiber consumption in U.S. textile industry.

Over the latest year's time, the loss has been a little less than two percent (from 36.3 to 34.4 percent). This is still not good. The competitive loss shown here at the textile mill level is roughly confirmed by the Council's Market Research staff, who study developments at the fabric and end-use level. They find that the competitive losses were still rather general across the whole spectrum of end-uses in 1969, in spite of occasional good news such as we had in carded bed sheets and in corduroys. But the tempo of the losses has been greatly reduced — and that is the big news now.

If the total domestic textile market had increased last year at its normal average rate of about a million cotton bale equivalents, and cotton's competitive loss had been no more than two percentage points, the actual size of our market would have had very little change. This has been the main story across many years of the past: With a rapidly expanding total market, cotton has managed in most years (but not 1967 or 1968) to keep its competitive losses small enough so that actual consumption of this fiber did not decline. It is still quite reasonable to hope that in the future we can make better use of all the competitive weapons that must be employed and thereby cause cotton to begin sharing in the market growth. This means adequate and effective research and promotion, a competitive and reasonably stable price, and a dependable supply of all the needed qualities. You have heard this for so long that you may be sick of it, but it is still the truth. We have a fiber so good, and a market so dynamic, that we have survived till now with a very inadequate overall effort.

Examine the record of our competitors in figure 5. The section of each bar located just above cotton represents rayon and acetate, both staple and filament. Obviously these fibers, taken as a whole, have had no spectacular competitive gains in recent years. Next come two kinds of fiber which, in most uses, are not very intense competitors of cotton; namely, wool and glass fiber. The glass has had a big gain, but if you add this with the other fibers just mentioned, the group as a whole has no net increase but rather a decline across the years represented in figure 5.

The noncellulosic share. — The entire market gain which we see in figure 5 has gone to the true synthetic or non-cellulosic fibers (nylon, polyester, acrylic, etc., both staple and filament). These fibers have almost doubled in domestic consumption within the brief space of four years. They went from an annual rate of 4.8 million cotton bale equivalents in the third quarter of 1965 to 9.5 million in the same quarter last year.

This hugh noncellulosic market could be broken down in a number of ways. In terms of cotton equivalents, the staple fiber and the filament yarn have roughly equal shares, and they have shared about equally in the growth. Among the staple fibers, polyester is now bigger than all the rest combined, and it has had the lion's share of the growth in this recent period.

Perhaps the most meaningful breakdown for us is into three large areas of utilization, which are shown in the chart. The first section represents just the polyester staple fiber which is blended with cotton or rayon and used in woven fabrics, largely in durable press. This use of polyester has tripled within 4 years, from about half a million to 1 1/2 million cotton bale equivalents, for a net gain of about 1 million. Nowhere is the competition with cotton closer than this, and nowhere is the loss more clearly cotton's loss.

The next section is the noncellulosic fiber used in knit fabrics. This rose from an annual rate of about 1,150,000 cotton bale equivalents in the third quarter of 1965 to about 2,183,000 in the same quarter of 1969. Here is another expansion of about a million bales in noncellulosic consumption within the four years. This represented the entire net growth in all knit goods across that period.

Next is a section of the bar representing noncellulosic consumption in rugs and carpets. This rose from a rate of 1,236,000 to 2,860,000 bale equivalents. The net gain was 1.6 million in a period of 4 years. Cotton's remaining share of this huge and expanding end use market is down to about 4 percent of it. Clearly we face a big challenge in this and in the other main areas of noncellulosic expansion.

It seems impressive that so much of the noncellulosic market can be summarized in these three large divisions. The remainder of the noncellulosic consumption is more widely distributed over a large variety of woven goods uses and other outlets.

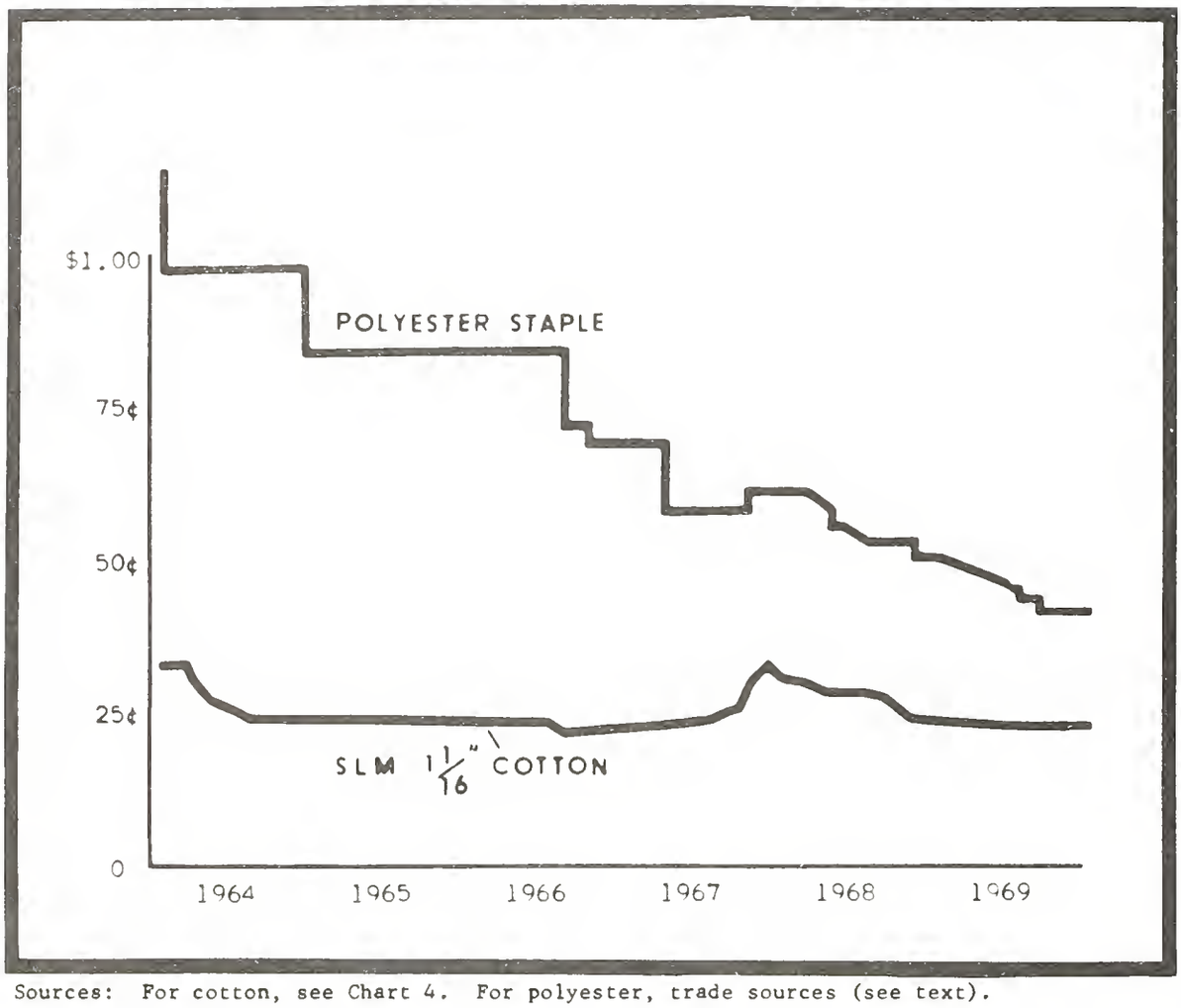
Polyester staple. — Cotton people should have a special concern about the invasion of their markets by polyester staple. We shall now look a little further into the particular case of that fiber.

The lower curve in figure 6 repeats the monthly average price quotations on strict low middling 1 1/16-inch cotton on the officially designated spot markets, but the curve appears lower here than it did in earlier charts. This is because the scale has been changed so that it will also accommodate the price record of polyester staple. What we are showing here is the approximate price of branded, apparel-type polyester, such as Dacron, Fortrel, and Kodel. Of course, we do not use the published or list prices, which have become quite fictitious in recent years if taken at their face value. We use prices obtained directly from reliable trade sources. It is increasingly difficult to speak of any one price as being typical for these fibers, but we believe that figure 6 gives a fair approximation for the leaders when sold on a branded basis. This kind of fiber has had a further decline of about nine cents a pound in the past year, from 50 cents in January 1969 to about 41 cents today.

The unbranded polyester, of first quality, is several cents below this figure. The carpet staple and a large variety of special types tend to sell at higher levels. But the general trend of the polyester staple market has had the kind of downward trend depicted in this chart. With this kind of price behaviour, polyester has tended to dominate the synthetic staple market in recent years, and it has become a real price competitor with cotton. This is not to say that price has become the only factor, or the main factor, in this competition; but it is indeed a significant factor.

Where will the downward trend of polyester staple prices stop? It is difficult to get dependable information on the cost of producing this fiber. The cost varies by kind of product, by size of plant, and by company. The people who know most about the subject are naturally not eager to talk. But it is obvious that the huge profits on production of this fiber are a thing of the past. It also seems virtually certain that a very substantial portion of today's production is being sold at the break-even point or below it.

Whereas branded polyester is priced at about 41 cents, the average price of strict low middling 1 1/16-inch cotton on the official spot markets is about 22.9 cents. But we have to look further in making a meaningful comparison in terms of the cost of the fiber to the textile companies which make decisions to use one or the other or some combination of the two. The actual difference in mill cost varies tremendously from one situation to another. We can get a broad impression if we think in terms, first, of combed goods, and then of carded goods.

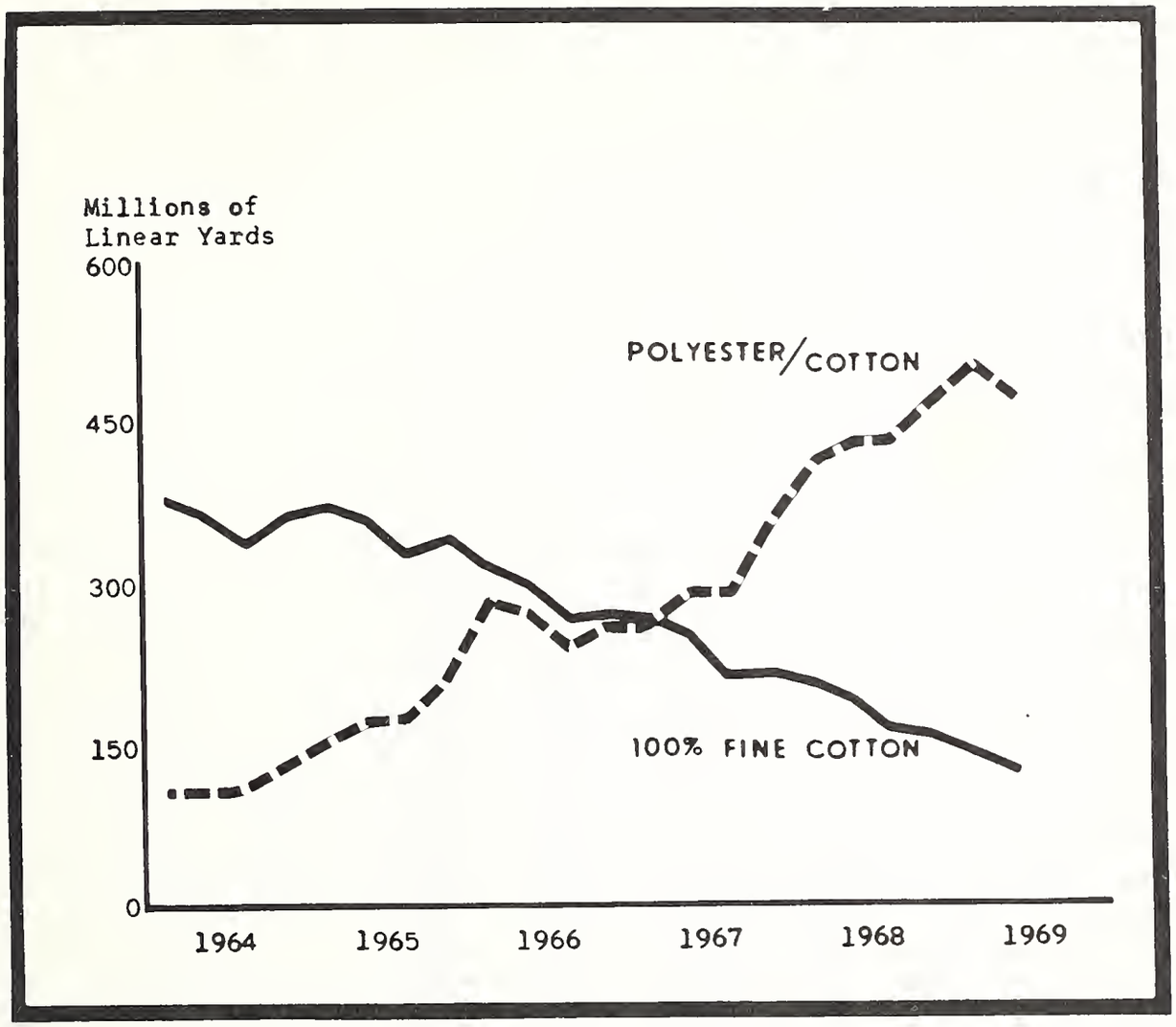


Sources: For cotton, see Chart 4. For polyester, trade sources (see text).

Figure 6. — Prices.

Where cotton competes with polyester staple in combed goods, it would be typical to think of a quality somewhat better than strict low middling. Middling 1 1/16-inch is priced at about 24.8 cents on average in the official spot markets. But, to compare with polyester, it should be priced on a mill delivered basis. The price in the Group B mill area is about 27.2 cents. In combed goods a typical waste factor for cotton would be 27 percent. When we allow for this, minus the resale of the waste, the cost on a basis that would compare with a pound of polyester becomes about 35.3 cents. Then something must be added in most cases to compensate for the higher strength of the polyester, which permits the use of lighter-weight fabrics with less fiber content. A typical allowance might be 30 percent, which would bring the cost of the cotton to about 45.9 cents, compared with 41 cents for branded polyester and less for unbranded. Even this analysis allows nothing for the fact that mills must carry the average bale of cotton in inventory for a considerably longer period than the average bale of polyester.

But it must be emphasized that the figures above relate to combed goods fabrics. It is in this area that we have already sustained most of our loss to polyester staple. This is evident in figure 7, where the quarterly production rates for two classes of fabric are compared. From the first quarter of 1964 to the second quarter of 1969, the production of spun yarn polyester-cotton blend fabrics rose from 105.7 to 467.3 million linear yards, while that of 100-percent-cotton fine fabrics declined from 378.3 to 125.4 million linear yards. (Fine cotton fabrics embrace the combed goods plus a small percentage of fine carded goods.) Some of the gain for polyester blends has already been at the expense of carded cotton fabrics, but it is apparent here that most of it has been from combed



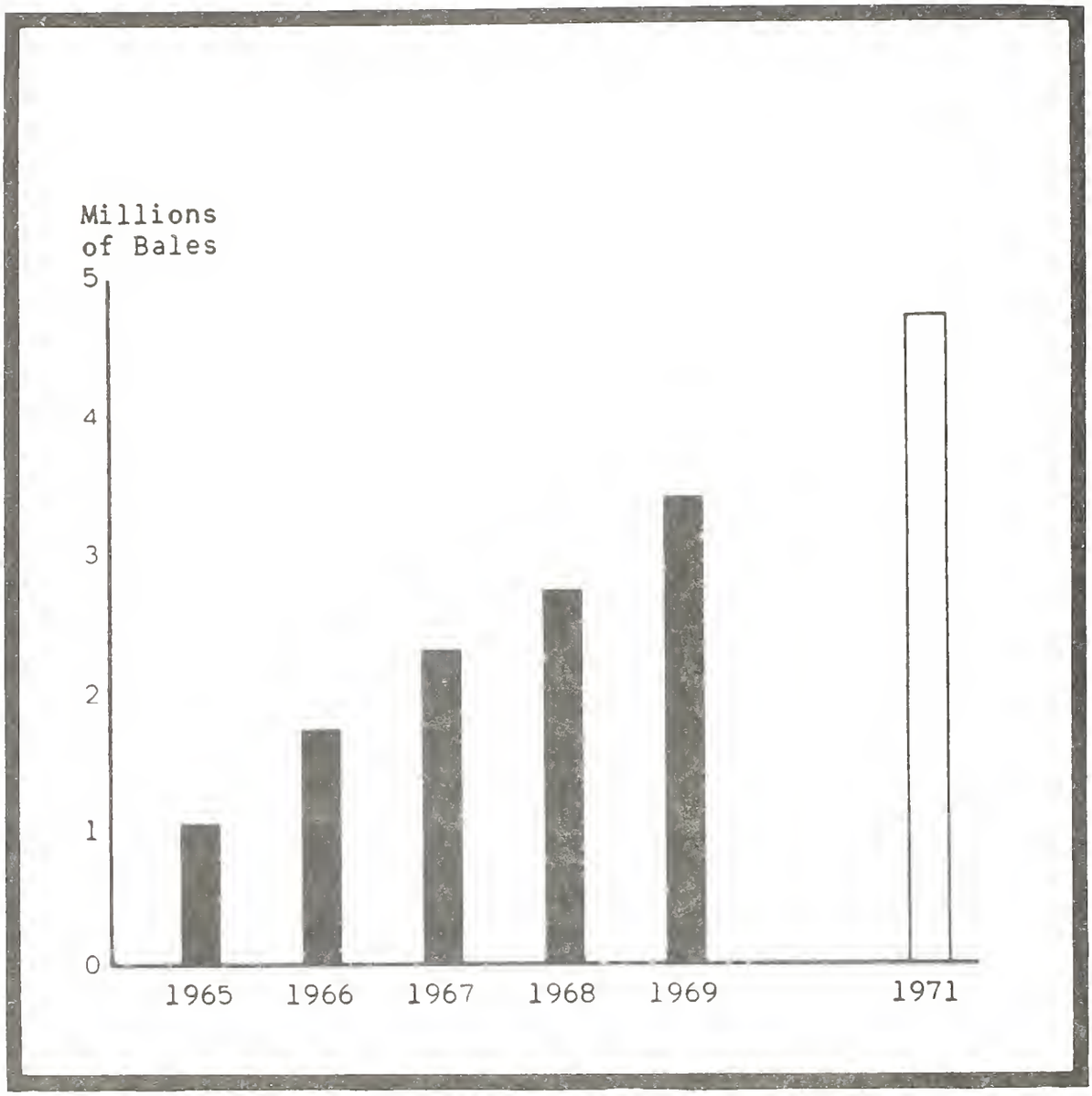
Source: U.S. Department of Commerce.

Figure 7. — Quarterly fabric production.

goods and that only a minor fraction of the cotton combed goods market is left. There is no dispostion here to give up on combed goods as a lost cause for cotton. On the contrary, cotton should fight very hard, through research and other means, to recoup its losses in this important market for high quality fiber. At the same time it should be recognized that the polyester manufacturers, in thinking of future inroads at the expense of cotton, must be training their sights more and more on the carded goods markets, which use a great deal more fiber than was ever used in combed goods.

A comparison of cotton and polyester staple in terms of true mill costs becomes a very different proposition when we move from combed to carded goods. For a typical cotton to be used in carded fabrics, there is no need to go higher than s :t low middling 1 1/16 inch. The net waste factor is seldom much over half the amount experienced in combed goods. And as for relative fiber strength, the advantage of polyester staple tends to diminish rapidly in carded goods, which are generally heavier. All in all, cotton tends to be cheaper in mill cost than polyester staple when the fabrics produced are carded goods.

But, in spite of this and in spite of the narrow or nonexistent profit margins in much polyester staple production today, the stubborn fact remains that the companies which make polyester staple are going right ahead with plans to build expanded plant capacity. In 1969 polyester staple production was about 2.6 million cotton bale equivalents. Plant capacity near the end of the year was 3.4 million, as we see in figure 8. According to the December issue of Textile Organon, the planned expansion would lift that figure by 1.3 million bale equivalents, or to 4.7 million, in the next two years.

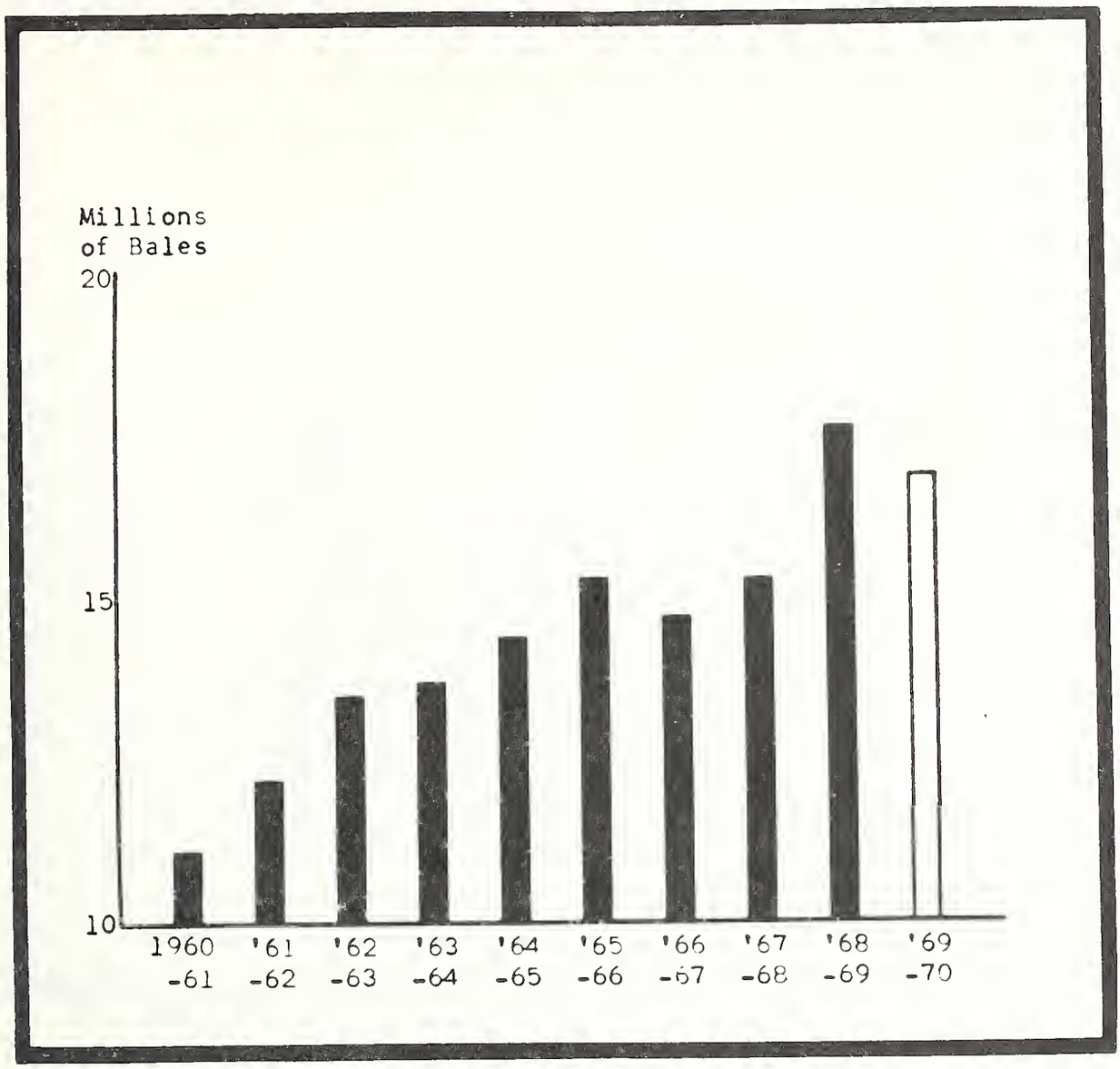


Source: Textile Economics Bureau data, converted to cotton equivalent with U.S. Department of Agriculture factors.

Figure 8. — Polyester staple capacity.

Why are polyester producers expanding at such a rate in the face of the cost-price squeeze that is already upon them? There can be several reasons. Some companies have to expand to reach an economic scale of operations; this may seem preferable to writing off as a bad investment many millions of dollars already spent on relatively high-cost capacity. Some may have faith in their ability to maintain premium prices on a good part of their production. Some undoubtedly are looking at the export field. This country has been a world leader from the beginning in the technology of noncellulosic fibers. It is already a substantial net exporter of polyester staple. But it must be added that every time we press a knowledgeable person hard for an explanation of the continued capacity expansion, he falls back mainly on the proposition that this is just the way the chemical industry behaves. It has a built-in tendency to expand capacity even to the point where its earnings trend is depressed. This is the kind of competition which cotton faces, and it is a rough kind indeed.

Raw cotton exports. — Now we come to the export picture for raw cotton. Here the big news of the current season is that foreign production is not increasing, but on the whole is evidently down somewhat.



Source: U.S. Department of Agriculture.

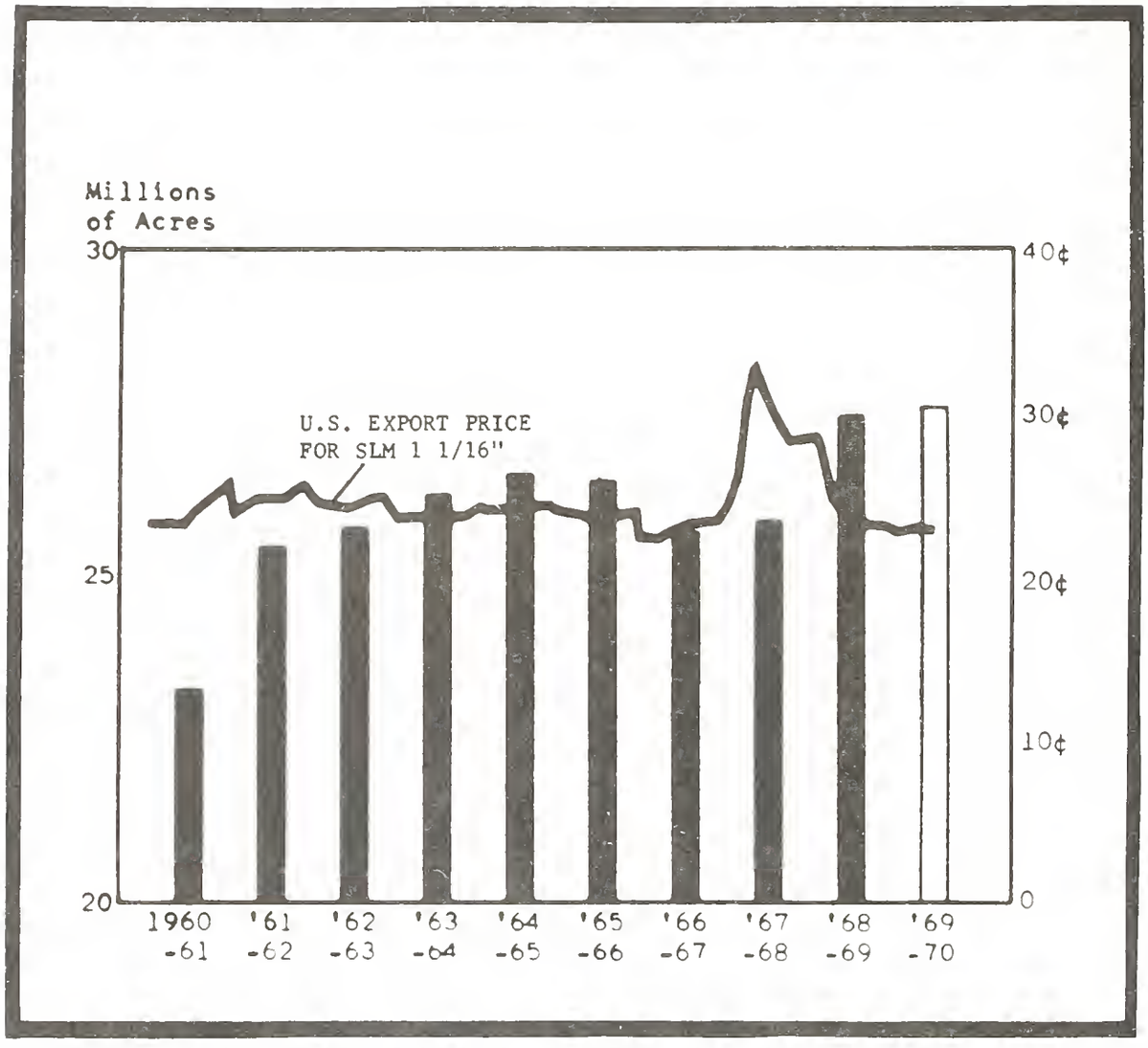
Figure 9. — Cotton production in free foreign upland cotton-growing countries.

Figure 9 represents cotton production in those countries of the free (or non-communist) foreign world which grow mainly upland cotton. This chart omits India, Egypt, Sudan, and Peru, which grow mainly other types. (Incidentally there is evidently some increase this season in production of the other types.) The record for each crop year of the 1960's is represented in figure 9. It should be noted that the chart has a reduced scale, extending from 10 million bales at the bottom to 20 million at the top.

In the upland-growing countries of the free foreign world, production increased by about 3 million bales from 1966-67 to last season, and reached 17.6 million. But now it appears that there is a reduction this season of perhaps 700,000. Also, the Russian production, which is not included in the chart but is strongly competitive with American upland, is evidently down this season by something like 500,000 bales.

Some of the decline in foreign upland production is due to reduced yields, but it is also interesting to consider the trend of reported acreages. Figure 10 gives acreages for the same upland-growing noncommunist countries. Here the scale goes from 20 million acres at the bottom to 30 million at the top. On balance the total acreage seems not to be down this season, but neither is it significantly up.

Figure 10 also has a curve for the average price of strict low middling 1 1/16-inch cotton on the official spot markets of the United States, with adjustments for the export subsidy which was in effect during the early years of the decade. The export price was fairly stable at



Source: U.S. Department of Agriculture. For price adjustments prior to August 1, 1964, see text.

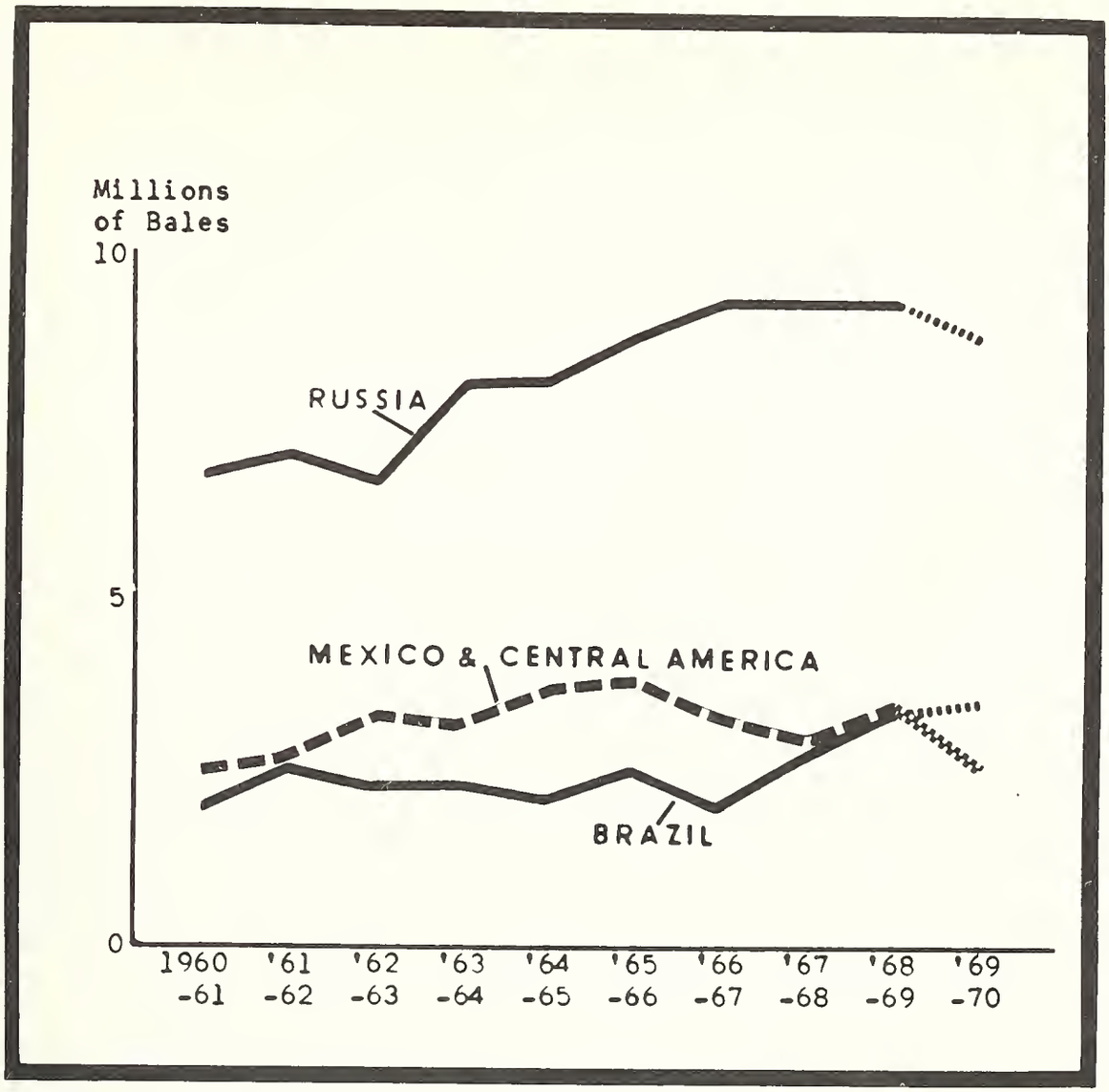
Figure 10. — Cotton acreage in free foreign upland cotton-growing countries.

around 23 or 24 cents for this quality throughout the 1960's until it took its brief sky ride in 1967. (The price for domestic consumption was higher than the export price in the early years of the decade, but the Agricultural Act of 1964 brought the domestic price down to the general level where cotton had been priced for exports all along.)

Foreign cotton prices did not follow the American price all the way up to its peak in 1967, but in general they certainly were pulled a big part of the way up, and they later came back down. Free foreign country plantings, especially of upland cotton, had lost their upward trend and were declining in the middle 1960's under the weight of rising costs and the price levels of that period. Then the price behavior in 1967-68 rejuvenated interest in cotton production in many countries. Now again, at the lower prices of today, the acreage has about stopped rising. It seems logical to hope that if prices are held at about the present level, foreign plantings might show some downward tendency again as they did in the mid-1960's.

Looking back, from where we are now, at what the price behavior of American cotton in 1967 did to its markets both at home and abroad, it seems evident that the U.S. cotton economy cannot afford to run the risk of a supply squeeze that might bring a repetition of that experience.

Russia, Brazil, Mexico, and Central America. — In figure 11 we have an indication of cotton production in three of the areas which get the most attention. These are Russia, Brazil, Mexico, and Central America. Obviously they go their separate ways.



Source: U.S. Department of Agriculture.

Figure 11. — Cotton production.

Russia has had no increase in production for 3 years, and this year it is down. Mexico and Central America, which once were in the forefront of our concern, have been cooling off for a longer time, and this year they are sharply down. Brazil did not make much excitement across most of the 1960's, but in the latest three seasons, including the estimate for the present one, Brazil is up by a net of perhaps 1 1/2 million bales.

We might ask why it is that this season, when other strong competitors are down in production more than Brazil is up, and when overall foreign production of upland cotton is down, a rising production trend in one country like Brazil can cause us so much agony. The Brazilians are certainly under-pricing United States cotton, but they always have done this when they had cotton which they were eager to sell.

The answer seems to be that cotton competition in the world market is more intense than it was three years ago, because in the past two seasons foreign production increased very substantially more than the foreign offtake. Production in the whole free foreign world rose more than three million bales, while offtake rose only about a million. We are living now with the aftermath of that development. It will be considered further when we get to table 2.

Table 2. — Cotton in the free foreign world (millions of bales)

Item	1966-67	1967-68	1968-69	1969-70
Consumption	25.4	25.5	26.4	26.6
Net exports to Communist countries and others	1.4	1.1	1.4	2.2
Total offtake	26.8	26.6	27.8	28.8
Production	22.8	23.9	26.0	25.7
Deficit	4.0	2.7	1.8	3.1
Stock change	+ .7	+1.5	+ .9	?
Total U.S. exports	4.7	4.2	2.7	?

Source: Cotton Situation (U.S. Department of Agriculture) January 1970.

In figure 12 we have a picture of the foreign demand for cotton across the decade of the 1960's in the free foreign world. The shaded area represents the net exports from the free foreign world to the communist world (i.e., exports minus imports). These net exports to communist countries, when added to cotton consumption in the noncommunist countries, make up the total cotton offtake of the free foreign world. Obviously neither consumption nor the total offtake has shown a very impressive rate of increase in the 1960's. There has been, however, a net rise last season and evidently a further rise this season. The 2-year increase may total a couple of million bales.

The basic, long-range problem for cotton is that manmade fibers have had the dynamic growth in textile markets abroad, as well as at home. Manmade fiber consumption in the free foreign world has gone from 12 to 30 million cotton bale equivalents in ten years. Manmade fiber consumption, when expressed in equivalent bales, is higher than the consumption or the offtake of cotton.

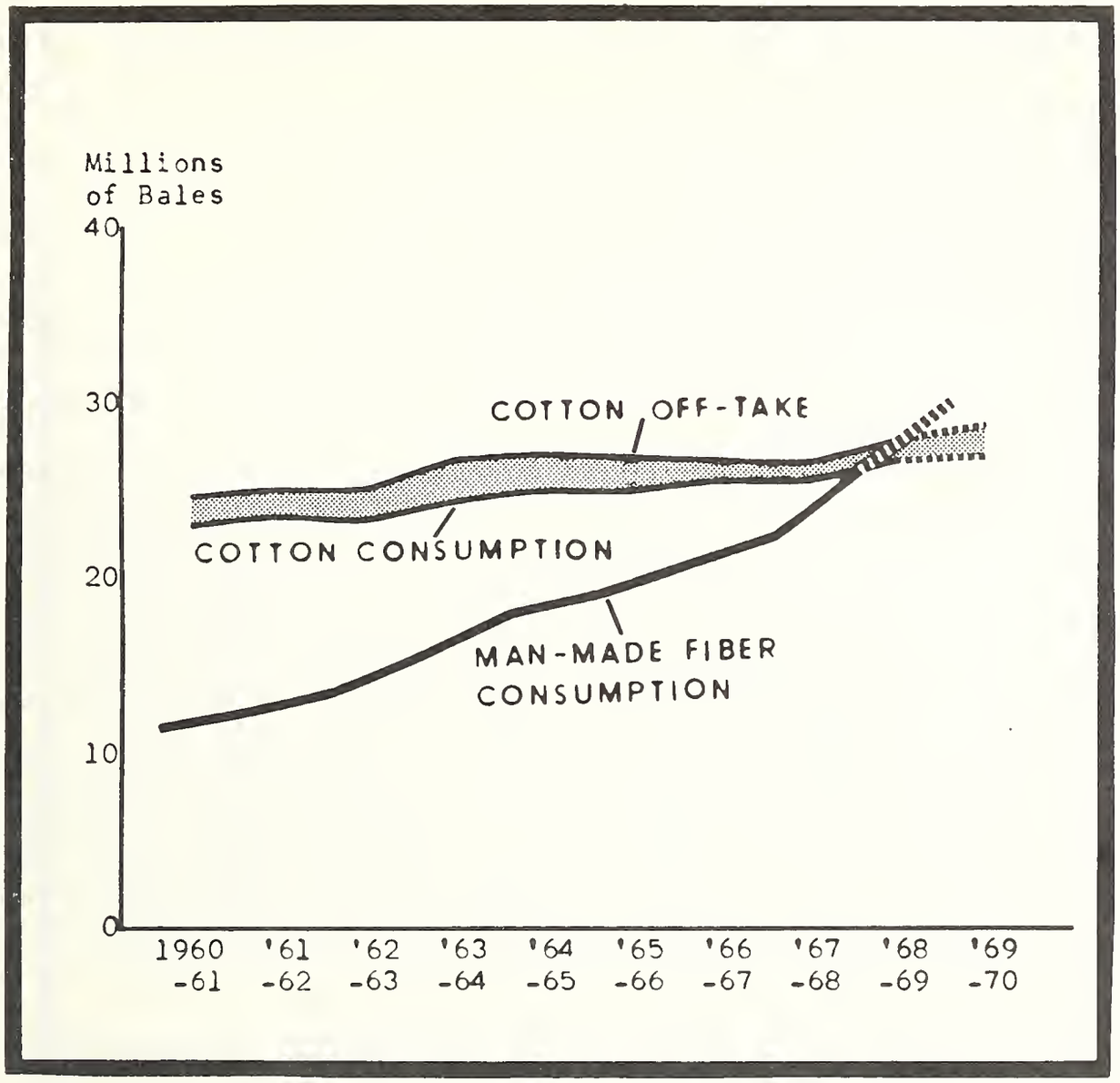
The long term future of U.S. cotton exports depends fundamentally on how well cotton competes with manmade fiber on the foreign markets and on how well U.S. cotton competes with foreign-grown cotton. If cotton is to make a better showing against the manmade fibers, it must make better progress in research and promotion, and it must maintain a price which is consistently competitive. To compete effectively against foreign-grown cotton, the export price of U.S. cotton must be at a level that will discourage foreign production, and above all another price experience like that of 1967 must be avoided.

Also, there is a big opportunity for credit to be used in ways that will get and hold some additional foreign markets for U.S. cotton. Where the appeal of our credit to foreign customers is strong enough, so that we can beat foreign suppliers to certain markets in spite of their price cutting, we have a competitive weapon which can help us override the hardship of being the residual supplier.

Stocks in exporting countries. — A development of increasing interest is the rise in raw cotton stocks held by the free foreign exporting countries. Figure 13 gives the stocks held by these countries on the opening dates of the latest ten seasons. These stocks rose 3 million bales (nearly doubled) in the last 5 years. They rose nearly 2 million bales in the last two seasons and stood at an estimated 6.7 million on last August 1.

There are several explanations. About half of the recent 2 million bale increase occurred in Brazil. The South Brazilian crop, which has had most of the big recent increase, is not harvested until spring-time, and therefore, it is virtually inevitable that as production increases, the August 1 carryover will increase. Also, as Charlie Russell of the Cotton Council staff brings out in his Mid-Season Foreign Trade Report[1/], the exporting countries have been exceptional in the strong upward trend of their cotton consumption. It has risen 25 percent in the aggregate during the last 5 years. This calls for a somewhat higher working stock for domestic needs to be held in these countries. Stock increases of the kind explained above do not represent any great threat to the future export market, because these stocks will need to be maintained.

1/ Mimeographed copies available from National Cotton Council.



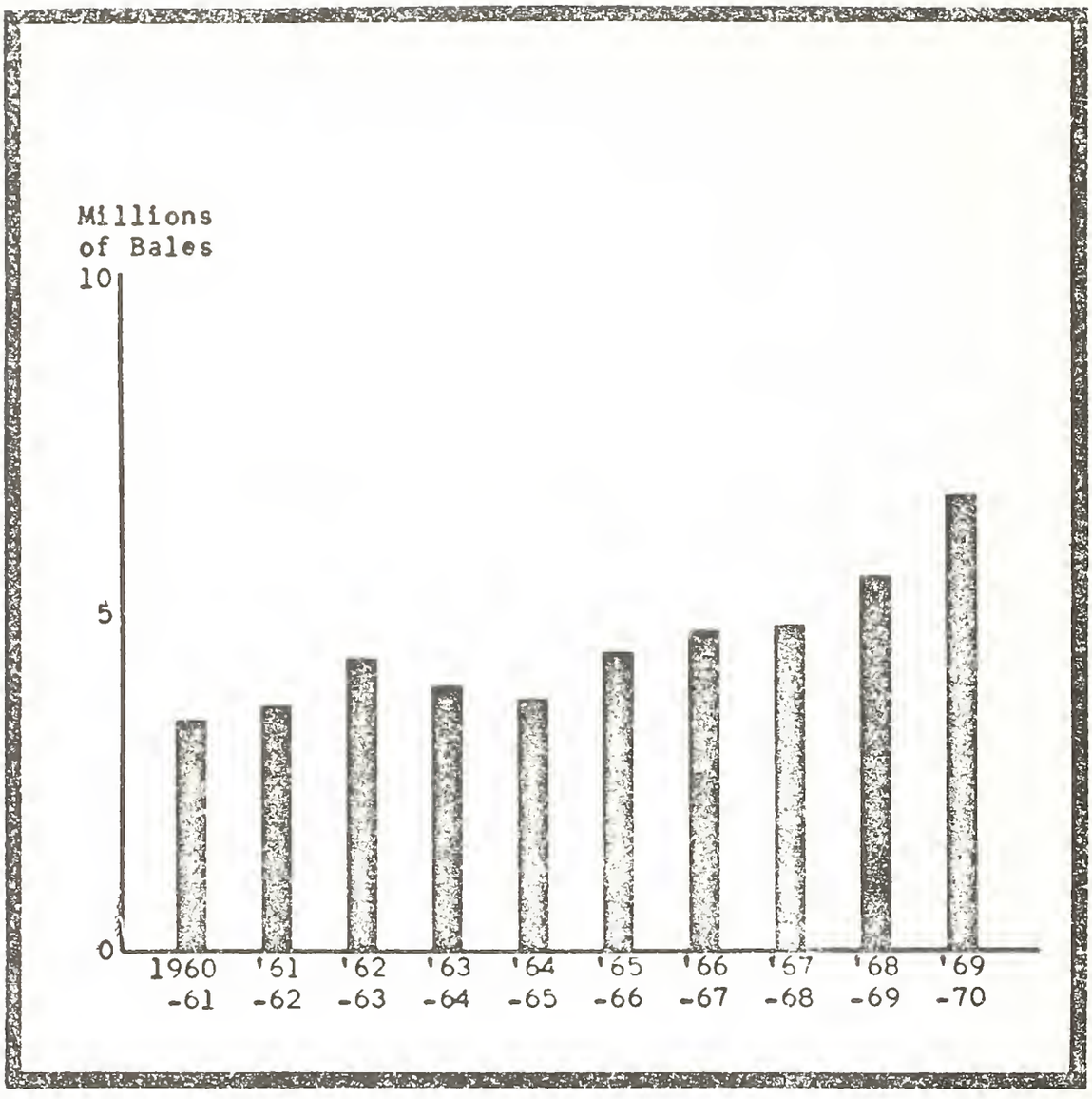
Sources: For cotton offtake and consumption, see Table 2 and explanation in text. For manmade fiber consumption, Textile Economics Bureau data, converted to cotton equivalent with U.S. Department of Agriculture factors.

Figure 12. — Free foreign world.

But not all of the recent increase shown in figure 13 is of the kind we have just described. It seems that some part of the increase in stocks means that a number of exporting countries have been holding more cotton than they need to hold at the beginning of the season. Some part of the increase may be worked down this season by unloading the cotton into exports.

It should be noted in passing that there may be a favorable side to this for U.S. cotton people. The very fact that foreigners are finding it necessary to assume a little more of the burden of carrying stocks in a time of low prices, should be a discouraging factor to them in their future planting decisions. If the United States is ever to get out of its residual supplier position in world cotton trade, more of this very thing will have to happen.

Exports: A summary. — In table 2 an effort is made to summarize a great many figures which enter into the export outlook and to give some preliminary ideas about the present season. These figures are in virtual agreement with those published 2 or 3 days ago by the U.S. Department of Agriculture in its latest Cotton Situation, although we have organized them differently. Aside from some slight differences due mainly to rounding, the only discrepancy is in the fact that we included under "Net Exports to Communist countries and others" the relatively small amount of cotton sold by United States exporters to Communist countries. We acknowledge that these sales do not fit logically into a table entitled "Free Foreign World," but they nevertheless should be included in an analysis designed to shed light on the overall U.S. export situation. All types of cotton are included in this table.



Source: U.S. Department of Agriculture.

Figure 13. — August 1 stocks in free foreign exporting countries.

It will be seen that the total offtake of cotton declined a little in 1967-68, but increased the next season and evidently this season. The net increase is perhaps 2 million bales or more. Production, on the other hand, increased in both 1967-68 and the following season, but is evidently down slightly this season, even when the projected increases in India and Egypt are included.

The "Deficit" in table 2 is the excess of the offtake over the production. This is often referred to as the "residual." The trend of this deficit is an indicator of the fundamental trend in the U.S. export situation. The deficit was reduced by more than half (from 4.0 to 1.8 million bales) between 1966-67 and 1968-69. Actual exports were well ahead of the deficit in each of the last three seasons, but this was because foreign stocks were increased in each of those years. Now this season the deficit is expected to turn upward, perhaps to 3 million bales. This is a most encouraging turn in this fundamental source of our exports. But it is thought that in this season, for a change, there will be a reduction in foreign stocks, pulling exports to a level below the deficit. Those on the pessimistic side feel that foreign stocks will be drawn down very substantially, pulling down exports perhaps to two million bales. The optimists (if we may use such a word in reference to figures of this size) feel that there may be a reduction in stocks, but only a moderate one, so that we shall export 2 1/2 million or more.

Can we meet the challenge of an upturn? — It is now more than 2 years since the skyrocketing prices of late 1967 took their heavy toll of U.S. cotton markets, both at home and abroad. Today, it is possible to observe that our cotton prices, taken as a whole, have been back down to their former levels long enough so that we can begin to hope again for market gains. The chances seem at least even or better that the next turn after this season will be up rather than down. This is true especially of exports, where the biggest short term changes normally occur.

An upturn in the demand would be a wonderful shot in the arm for this industry, provided we have the cotton to supply it smoothly and efficiently. But whenever the upturn comes, if we greet it with a supply position which sends prices rising sharply again, we will just be continuing the game of downhill leapfrog for cotton — from smaller supplies to smaller markets to smaller supplies to smaller markets.

Now that we are back to the lowest carryover in nearly two decades, and facing far stronger synthetic competition than ever before, the problem of maintaining an adequate supply is one of the most urgent that we face. Cotton can never really get back on its feet if the policy should be to guess at the next year's demand and then aim at producing barely enough to meet it. There are too many big unpredictables: The weather at home and abroad, the textile cycles at home and abroad, and so on. We have to take the risks and costs of building up a surplus in years when the pendulum of fortune swings one way, if we are to avoid the greater risk of more experiences like 1967 and its aftermath when the pendulum swings the other way.

To get enough production, the farmer must have an adequate incentive to grow the cotton. It certainly has to be something better than a gamble on the chance that a short supply will give him the kind of fleeting and damaging spurt in his price that occurred in 1967-68. We could not repair the losses to our markets by producing more cotton in later years after the markets were gone.

Last season and the season before, we had competitive losses at home and abroad which broke all records. This season we are still getting losses; but the pace has slowed a great deal, and there are signs of encouragement for the future if we can mount the needed overall program.

This has to include big and effective research and promotion efforts, a competitive price, and an adequate supply at all times. And the control of imports, which have become so big, has to be an integral part of it.

The parts of that program cannot stand alone. We could do great things in research and promotion and yet see all the benefit go down the drain because of imports or a short supply. We could have a competitive price and yet see our markets go down and down through the years because the other things were neglected.

And basic to the whole effort is the fact that the cotton producer must survive and have a reasonable chance at future prosperity. The need is urgent to get costs down through progress in research and in other fields, and thereby to get the future of cotton on a firmer foundation. This will take time, but the need for an incentive to produce enough cotton is immediate and is essential to the success of everything else that we are trying to do.

USE TRENDS AND POTENTIALS OF COTTONSEED MEAL

by

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Memphis, Tenn.

While we think together today on the competitive and utilization positions and the potentials of cottonseed meal I hope we can pull together a broad framework of the cottonseed meal situation. Many times and in many ways individual facets of the subject have been reviewed in detail. If we can make some progress in crystallizing our understanding and possibly our future plans in this discussion, I shall be satisfied.

Purposely, I shall avoid detailed technical reviews. At this Clinic last year I did a general review of the scientific literature. Since that time, Keith Smith and Kenneth Lewis have prepared excellent reviews of our internal use and copies of those will be made available upon request. Earlier, Richard Phelps and several others published classic reviews. While I shall make reference to pertinent broad principles, there is not a need for me to review the literature again today.

I hope we can concentrate on where we are, why we are there, where we may want to be in the future, and how we can achieve the objective which we may choose. I want to emphasize early that we do need to chose our individual and collective objectives carefully and work vigorously toward them.

Let us first look at the size of our market in comparison with other high-protein feeds. The total supply of high-protein feeds for this marketing year is about 23 million tons. Oilseed meals represent about 79 percent of the total. It is estimated that about 83 percent of our supply of high-protein feeds will be retained for domestic feeding, and cottonseed meal represents approximately 10 percent of that domestic use. Thus, although cottonseed meal runs neck-to-neck with meat meals for the position of being second to soybean meal in total volume, it provides only a relatively minor portion of the supply and, like all other protein sources, is dominated in the market place by soybean meal. Cottonseed meal, meat meals, and grain protein feeds are also distinctively different from soybean meal in secondary or byproducts for which there is poor correlation between production and demand.

We must now recognize that when we discuss high-protein feed supply, utilization, and price we must include the synthetics — urea and other nonprotein nitrogen sources. The Economic Research Service of USDA now estimates that the use of urea for feed is approaching 800 to 850 thousand tons. Since 12 pounds of urea and 88 pounds of milo equal 100 pounds of 41-percent-protein cottonseed meal in protein equivalent and energy content, we can calculate that urea is adding about 7 million tons of cottonseed meal equivalent to the supply, bringing it up to around 30 million tons total or 26.5 million tons available for domestic feeding.

While we all talk much about the competition from urea, we must realize that soybean meal is our primary competitor and dominates the market. We often refer to cottonseed meal as the protein of choice for ruminant animals, but we seldom stop to recognize that in 1967-68 about 4-1/4 times more soybean meal than cottonseed meal was fed to those animals.

It is difficult to evaluate with any preciseness the effect of the dramatic increase in urea feeding upon the protein market. Generally, during the sixties the price index of natural high-protein feeds was good in comparison to the index of livestock prices and of feed grain prices. Many who view the protein situation from a national standpoint believe that urea affects soybean markets the most. We, in the cottonseed industry, are inclined to believe it affects cottonseed meal prices to a greater degree because our markets are primarily in cattle and sheep feeds. This view is supported by the fact that a large proportion of the commercial feedlots are located in our geographical markets and urea has been especially strong in commercial feedlots. We have seen occasions, especially in the Far West in 1968, when this competition severely affected cottonseed meal movement.

I should pause here to point out that the potential for use of urea in dairy rations is even greater than in feedlots. In 1966 the crude protein consumed by dairy cattle was 127 percent of that consumed by feedlot cattle. However, the limitations on urea use in dairy rations are greater because the dairy ration is higher in protein and a large volume of urea can cause a palatability problem which the dairyman will not tolerate.

It hardly seems necessary to mention that if exports of soybeans and soybean meal had not been maintained at high levels it would have broken the protein market. We have enough difficulty in explaining the dramatically increased domestic use of high-protein feeds. Obviously, the explanation lies in increased production of livestock and favorable livestock prices. Population growth and increased personal income have created greater demand for the premium foods we prefer. Beef consumption is the primary example. In 1960 the average factory worker purchased about 2.8 pounds of choice beef with an hour's pay. In 1969 he purchased about 3.3 pounds for an hour's pay. As a result, the per capita consumption of beef increased 30 percent in the sixties, permitting an increase in beef production of 40 percent which was mostly in increased feedlot fattening.

We could emphasize that we have not shared in the increased use of protein by beef cattle and that the amount of meal used in feedlots is far less than in 1960. However, we have some difficulty in evaluating how the feedlots would have fared without urea. The economy of using urea undoubtedly had some effect upon the doubling of the number of fed cattle during the sixties. Without urea, oilseed meal prices probably would have been higher but we cannot pinpoint how much higher because total demand for protein feeds of all types would probably have been lower as demand reacted to price.

The cow-calf operation is our greatest stronghold. Cottonseed meal has established a prestige position and generally is preferable to urea-containing supplements. It is my personal judgment that we need to do everything we can determine to be productive to hold this market. This would appear to involve promotion, customer service, and competitive pricing. The high prices which many ranch and farm customers are paying for cottonseed meal and cake this winter season are causing them to search for substitutes. If they go in this direction next season, we simply have to buy our way back into this market.

Now, let us go for consideration of the ruminant to the nonruminant feed market. For 15 to 20 years our Association has been committed to the position of narrowing the preference gap between cottonseed meal and soybean meal in poultry and swine feeds. The problems that have confronted us are gossypol, available amounts of essential amino acids, energy content, and cyclopropenoid fatty acids. I believe I can be conservative in saying that we have made much progress toward our objective. The percentage of our production used in swine and poultry feeds has increased from about 8 percent up to somewhere between 25 and 33 percent. Yet, we have a long way to go because much of this increase has been possible because cottonseed meal could be bought at a lower price than soybean meal. We desperately need to find the poultry and swine feed manufacturer using cottonseed meal at a price closely approaching soybean meal and not just when he can buy it at a significant discount.

In my opinion, gossypol is a highly significant factor, and we can completely eliminate it only by using glandless cottonseed or by changing to a different type of processing. Without plowing old ground too much, let me remind you that the feed manufacturer is afraid of gossypol and this psychological barrier must be removed. Our research has shown us how to avoid toxicity and other major negative gossypol effects, but I am afraid we have not adequately convinced the feed manufacturer. Our Association and every oil mill operator who wants to sell to the feed manufacturer need to get this information to those who formulate feeds. It is somewhat ironical that our research results in the inactivation of gossypol with iron salts are being used extensively in Mexico but only a relatively few domestic feed manufacturers are using it.

We need to spend more time stressing the fact that a limited amount of cottonseed meal, used in a practical ration which contains other sources of high-quality protein, will produce results equal or superior to soybean meal alone. The popular conception of cottonseed meal is based too much on basic research feeding trials in which cottonseed meal, often of poor quality, was the sole source of supplemental protein. Those studies were useful to us in learning what we must do to improve cottonseed meal, but they are not very helpful in selling cottonseed meal to the feed manufacturer.

The cyclopropenoid fatty acid problem is of minor importance. Solvent meals are so low in residual fat that effective amounts of cyclopropenoids are not included in practical rations. The only major problem here is in the use of liberal amounts of high-fat meals in laying rations.

Protein quality as defined by amounts of available essential amino acids, specifically lysine, is a problem of some magnitude if cottonseed meal is to be used in liberal amounts in poultry and swine rations, especially those fed the younger animals. A soybean meal-grain ration is just about borderline in lysine for rations fed growing monogastric animals. The lysine content of cottonseed protein is about two-thirds of that of soybeans. Furthermore, predominant cottonseed processing procedures may inactivate 10 to 35 percent of the lysine according to the severity of the processing conditions. If one assumes that 90 percent of the soybean lysine is available, he may find that the cottonseed protein he uses to replace soybean provides only one-half to two-thirds as much active lysine. The difference must be replaced by supplementation with a lysine-rich supplement. This is the primary reason we say that under the best processing conditions the monetary value of cottonseed meal will only approach that of soybean meal.

Cottonseed meal has been traditionally processed for ruminant animals which make effective use of fiber. Nonruminants do not utilize fiber and, therefore, the energy value of cottonseed meals which contain liberal amounts of hull particles to regulate the protein content to 41 percent have lower metabolizable energy values for poultry and swine. When we remove sufficient hull particles to produce a 50-percent-protein cottonseed meal the energy content is very nearly the same as that of soybean meal. However, as I reported to you last year, some cottonseed meals may contain less than two-thirds the energy value of the best soybean meals. The protein percentage of the meal produced primarily becomes an economic decision. Obviously, a high-protein, low-fiber meal has higher feeding value than the conventional 41-percent-protein meal. However, no mill will convert to 50-percent-protein until the market justifies the move.

There are two nonruminant feed markets of considerable interest to us, and we will be attempting to test the value of cottonseed meal in these uses in the immediate future. These are for adult breeding swine and for raising laying pullets. In both instances the requirements for essential amino acids and energy and the susceptibility to gossypol are less than with the very young animals. It appears to be a good opportunity for the use of more cottonseed meal.

The complexity of the factors relating to optimum use of cottonseed meal in nonruminant rations is so great that I have been tempted to depart slightly from my intention to keep this discussion on a nontechnical level. Even so, I have been inclined to oversimplify some very important factors. Nevertheless, we need to sum up what we should be doing to participate more fully in this market.

First, we need to remove the fear of poor performance of animals that are fed cottonseed meal. These nonruminant rations are going to be formulated by computer and the computer programmer can restrict cottonseed meal to a low level or even zero because of his fear. We can remove that fear by providing well-documented facts from our research program.

Second, we need to create an understanding that when cottonseed meal is used to provide a limited but significant part of the protein in a nutritionally balanced, complete ration for swine and poultry it performs very efficiently.

Third, we need generally to become much more conscious of the need to process cottonseed meal for the nonruminant animal. We learned a long time ago that the variation in biological values of cottonseed meals is very wide and this variation can be fully accounted for at the mill by the conditions of processing. We must process for the market in which we want to sell and then we must inform our potential customers of the improvements we have made by using suitable processing techniques. While these changes appear to be necessary if our products are to become truly significant in nonruminant feeds, I do want to stress that the decisions made should be strictly profit motivated. I don't happen to believe that the world will necessarily beat a path to the doorway of him who makes a better mousetrap. The feed trade is looking for a better product but you have to let them know you have it and at a price which will make them want to buy. Furthermore, that price and any increased costs of making a better product have to balance out to a profit on your books.

A discussion of potentials would be incomplete without some reference to glandless cottonseed meal. Glandless meal naturally will not help you in the cattle and sheep feed market. In fact, there might be some initial sales resistance on the part of the traditional cottonseed meal feeder because it will not have the golden color. The product will offer distinct advantages in the nonruminant feed market but the magnitude will depend upon how you process the meal. When Wilda Martinez and co-workers autoclaved hexane-extracted, glandless cottonseed meal for 20 minutes at 250° F., the nutritive index was reduced from 101 to 76. Properly processed glandless cottonseed meal has been shown to closely approach the nutritive value of other high-quality protein sources. However, the lower original lysine content of cottonseed protein mentioned earlier will always have to be considered. The absence of gossypol will have several distinct advantages. It will eliminate both the possibility of real dangers and psychological distrust. Furthermore, there is good evidence that under normal processing conditions less lysine will be inactivated than when gossypol is present.

I believe we might conclude that generally we have done quite well in the market place with our meal in the past, with the exception of periodic seasons when the cattleman has not had extensive need for supplemental feeding. Cottonseed meal and cake have been preferred farm and ranch supplements for many years but there is little doubt that the position is being eroded. Urea has undermined many local markets and those mills that have depended heavily upon feedlots have been hurt the most. We have made significant gains in poultry and swine markets but we cannot delude ourselves into believing that it has been on an equal price basis with soybean meal. Nevertheless, it has been a very real achievement because it has been against very heavy prejudice and it has demonstrated that when mills decide to process meal for nonruminants they may improve their position.

Naturally, the future is less clear than the past. Production limitations probably create a more favorable impression on our competitive position than actually exists. It is probable that, with the exception of certain local areas, we need to fight much harder than we have to retain a favorable outlet in the cattle feed market. It is difficult to foresee more than maintaining this outlet and we shall probably lose more and more of it. The need to become really competitive in nonruminant feeds appears to be as great or greater than ever before. To achieve this goal, we need to give more attention to production of the best possible product, become more effective in education and sales activities, and get glandless cotton into production as soon as possible.

Finally, we cannot ignore the significance of price even though we have little effect upon it. Lack of stability of price is one of our greatest handicaps. Unexpected lows can wipe out mill profits and unreasonably high prices are the greatest stimulant to competition. Also, when we improve the market price by becoming more competitive in nonruminant feed and human food markets we are, to some degree, giving up our traditional cattlefeed markets. It is a factor which must be considered as we move forward to the position to which we obviously are committed.

SESSION II: K. F. Mattil, Texas A&M University, College Station, Tex., Chairman

PANEL DISCUSSION: STATUS OF THE PRODUCTION AND PROCESSING OF GLANDLESS AND GLANDED COTTONSEED

PRODUCTION – GLANDLESS AND GLANDED

by

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My remarks will be brief.

I want to share with you some observations and thoughts on the contribution of the breeder-seedsman to improve cotton production.

I'm a breeding technologist, comfortably at home with such matters as germplasm sources, mating systems, selection schemes, testing and evaluation techniques, and with the gamut of operations, from drawing up planting plans to sampling seed and lint at ginning, which make up a working cotton breeding program. Right decisions and a little luck in the area of breeding technology and program operations will result in an improved cotton.

I don't intend to cover the specific traits cotton breeders are working with. I refer you instead to Del Deterling's excellent account of this subject "What Are Cotton Breeders Up To Now?" in the February 1970 issue of the Texas, Oklahoma, New Mexico, and Arizona edition of The Progressive Farmer (pp. 30 and 31). I want to talk with you not about breeding technology but about the business end of the seed trade – the seedsman.

The question I want to confront you with is how does a new improved cotton variety move from the breeder's hands into production? Assume, if you will, that the breeders – let's say your breeder – has come up with an incredibly good cotton. The research and development is complete. Tests and other evaluations indicate this cotton to be a world beater. You, the seedsman, must now come to a decision: should you or shouldn't you offer planting seed of this cotton for sale? Manufacturers make similar decisions on whether to mass produce and sell a new product developed by research and development.

Such "GO/NO GO" decisions are greatly influenced by profit motives. Note, too, that it takes a good amount of capital to set up the production, distribution, and merchandising of a new product, including planting seed. It isn't generally recognized or understood that cotton planting seed – any seed for that matter – is subject to economics of production, distribution, and merchandising. The many verbal and written battles fought over the need for breeders' rights protection have been waged against such ignorance.

Figures on what it costs to place planting seed of a new cotton variety on the market are not available, but I have heard guess estimates ranging as high as a third of a million dollars. That is moderately expensive. With seedsmen's profits generally limited to the first few years after release of a new variety – due to the fact that anybody can increase and sell seed of the variety – the return on the seedsmen's investment is slow in coming in.

The point I wish to make, and I will go home happy in the thought that at least one person here received this message, is that a newly-bred cotton doesn't just find its way willy nilly into planter boxes. Just as a cotton variety is made to happen so it is with acres planted to that variety. The latter happening is brought about through merchandising which is motivated almost entirely by profit incentives. The maxim "It takes money to make money" applies. Financial circumstances play an important role in decisions to launch a new cotton variety.

The seedsman takes particular account of what the producer incentive will be to buy seed of the new variety and plant it. Since most cotton planting seed is sold through gins, the ginner's interest in making a buck is also given consideration. However, the producer is the seedsman's only customer. Hence, the producer's interest is paramount to the seedsman. The seed which will make the producer the most money is the seed he'll tend to plant.

Considering then the economics involved, will new cottons with improved lint quality continue to be offered for sale? I think so. Basically I see no signs that breeders are letting up or intend to let up in their push for better quality. The seedsmen's question is, "Will quality cottons make more money for his customer, the producer?" The answer is a qualified yes.

Everyone here is aware that price per pound of lint is related to its staple – the longer the staple the higher the price. For equivalent yields the producer will receive more income by planting the longer staple cotton varieties than by planting shorter ones. Depending on production costs and price differentials the longer staple cottons can still be more profitable to grow than shorter staple ones. Given that the traditional marketing picture continues, it pays to grow longer staple varieties provided they yield favorably. Yielding ability is an essential qualification.

The seedsman's variety release decisions are affected by end use requirements only insofar as the price differentials paid for certain lint and seed qualities offer an incentive to the producer to buy and plant a quality variety in preference to another with low quality. If the incentive is not there or does not materialize within a few years after introducing a quality cotton variety, business economics dictates that it will be withdrawn or replaced. We have seen these things happen in the last few years.

What about glandless cottons? Breeders continue to make excellent progress. In addition to the variety "Watson GLID," several breeders have developed materials of varietal status, which I look to see released in the next few years.

The answer to the question: "Will the seedsmen risk the capital investment required to move these breeders' developments into the seed trade?" appears at this time to hinge mostly on their ability to foresee what the markets will be for glandless cottonseed products and to what degree market prices will be translated into incentives to producers. What the seedsmen decide to do with these glandless cottons appears to depend largely on development of end use markets in the next few years.

Unlike the lint market, glandless cottonseed product markets are just now developing. The potentials for such markets are great. Thus, in the initial stages of glandless cotton production, and that is where we are and will be for a while, it seems to me that the seedsmen's financial risks will be higher than they will be after markets become established. Markets ought to develop along with increased glandless cotton production. As the seedsmen's risk diminishes, the flow of glandless cottons into the seed trade should pick up. The critical time is now when both supply and demand, that is, production and markets, are being developed simultaneously.

Another point of view holds that glandless cotton will make it as cotton first and foremost and as glandless only incidentally. Let no one misunderstand: glandless cotton is cotton and not an oilseed crop that bears a familiar resemblance to cotton. But the fact is that any increased value attached to glandless cottons of equivalent lint qualities and yield lies in the seed. A byproduct to be sure, yet one with potential for increasing cotton's worth. As this potential is tapped and its value realized, profit incentives should develop around glandless cottonseed.

A real question remains: "How much more will glandless cottonseed be worth compared to glanded cottonseed?" The answer lies in product value in the various markets and production and processing costs. However, what is needed now as never before is a supply of glandless cottonseed. Production of glandless cottonseed will go far toward resolving this argument. Now is the time for ingenuity and fortitude — a little patience wouldn't hurt either — while we pass through the initial stages of glandless cotton production and market development.

In summary, cotton varieties are developed by breeders and merchandised by seedsmen. The latter make decisions predominantly based upon profit considerations — just as in any business. However, profit motives seem to play a negligible role in breeding decisions — just as in any research and development department. It is my contention then that profit incentives have a major effect on whether or not a cotton variety, be it glanded or glandless, is even made available for planting because business decisions guide the fate of a cotton once it leaves the breeder's hands.

DISCUSSION

QUESTION: Dr. Miravalle, if you were selling seed and you walked up to a man who had never planted cottonseed before and you had two to offer — glandless and glanded — how would you succeed in selling the glanded seed?

DR. MIRAVALLE: Today, I'd have to develop a market to create the incentive. I'd have to work very closely with the oil mill industry to develop that market. Right now, there is no market.

QUESTIONER: I think you misunderstood my question. I was thinking of a person who had never planted cottonseed but who had traditionally grown it. What incentive would you give this person to plant glanded instead of glandless seed? Do you think you could?

DR. MIRAVALLE: I did misunderstand. I thought you said sell glandless seed. Perhaps the question of incentive isn't applicable in the situation you present. Let me turn your question about somewhat to see if I correctly grasp the nature of your question. If we have always had glandless cottons instead of glanded cottons and for some reason or other breeders developed glanded cottons, how would seedsmen go about selling planting seed of the newly developed, glanded cottons?

QUESTIONER: That's what I'm asking.

DR. MIRAVALLE: I can't think of enough of an incentive one could offer the producer to induce him to plant glanded cotton in preference to glandless cotton in such a situation. I am presuming that what we consider today as potential markets and uses for glandless cottonseed protein products will have already been well established and functioning if glandless cotton were the traditional type and glanded cotton the new type. I am also presuming that lint yield and quality, especially yield, of the glandless cottons, having been bred over a longer period of time, will be higher than that of the glanded cottons since these glanded cottons would have been bred for a shorter period of time. However, if a person isn't

familiar with cotton, I assume one could offer him glandless or glanded cotton planting seed on the basis of which one would make him the most money. In short, offer him a profit oriented incentive. I don't really feel I have done justice to your question.

QUESTIONER: This is the thing that struck me. There's been such a problem of trying to convince growers to grow glandless cotton, I just think about the time zero when, you know, nobody had any preconceived ideas of what was good and bad. I kept wondering how you would sell glanded seed if glandless were available and you hadn't been able to think of a sales pitch.

COMMENT: I think what you're driving at, and I don't consider myself that close to the subject, is that you come up with the feeling you've got to ask yourself, "Who grows glanded cottonseed?" I am sure there are reasons, but I don't think they come out. Someone like myself who is not really an intimate part of the cottonseed industry gets the feeling that the answer is not really coming out.

DR. MIRAVALLE: This is certainly the problem, but I believe that this is largely due to the fact that we are racing ahead of ourselves. We are so anxious to have glandless cottonseed proteins. You are aware that, today, glandless cotton varieties are limited in number, in areas of adaptation as well as in quantity of planting seed. At this time we don't have glandless cottons to offer all over the world.

QUESTION: Is there a fiber from glandless cotton that is poorer than the glanded? Also, does the farmer have an incentive to grow one or the other?

DR. MIRAVALLE: Breeding for desired fiber properties has presented no problems in developing glandless cottons. Breeders have experienced problems in increasing lint yield to acceptable levels and with obtaining desirable combinations of other characteristics. Increasing lint yield, while bringing along desirable combinations of other characteristics, is a general cotton breeding problem. If we were interested only in making a cotton glandless, this would be a simple genetic problem; but, of course, we want glandless cotton to contribute to the improvement of the cotton crop — this is a breeding problem. Please understand that yield improvement in any kind of cotton breeding effort is the number one and most difficult problem. Difficulties with improving yield are not specifically related to glandless cotton breeding. For example, when breeders across the eastern part of the Cotton Belt — from west Texas eastward — decided that it was worthwhile to improve the lint quality of cottons and they began to work in this direction. They had problems with getting the yield of these higher quality cottons up to the yield of their "bread and butter" cottons. But, these breeders kept on working so that today the yield differential between high quality cottons and the "bread and butter" types has diminished. I look for the same thing to occur in glandless cotton breeding. This breeding problem is not insurmountable. Yield is being improved in particular glandless breeding programs. Some breeding programs have not had problems in getting yield up to what that particular program has in their "bread and butter" cottons. So, for these breeders developing good yielding glandless cottons with acceptable lint quality has not been a problem. Technically, one can reasonably view yield improvement in glandless cotton breeding programs as a temporary problem which can be expected to disappear in time as breeders pursue their work. Breeders have come a long way in making cottons from the poor genetic stocks they started with in the late 1950's. I have personally observed glandless breeding lines in the course of my work with cotton breeders which gave every appearance of being excellent yielders. Therefore, I would have to say again that yield improvement in glandless cotton breeding is a qualified problem — here today and expected to be gone tomorrow.

QUESTION: I'd like to go back to the question about status of glanded seed. If you were a cotton farmer, Dr. Miravalle, and you weren't trying to plug glandless seed like you are now, what would you plant and would this be different in different parts of the country?

DR. MIRAVALLE: I really consider this an unfair question because I am not a cotton farmer. I can't answer the question any more than I can answer questions truthfully and faithfully of what I would do if I were a crusher and I received glandless cottonseed. My answer would be my own and would not really be applicable. Now, ask me a breeding question and I can give you a better response, but to ask me what I would do as a farmer is asking what a nonfarmer who thinks he might be a farmer would do.

QUESTIONER: That's what I wanted to know.

DR. MIRAVALLE: Remember, now, we are just getting started and it's troublesome times whenever you are getting started with anything. The incentives in today's situation would not be what we'll have five or six years from now. You must have some sort of incentive and that incentive is probably going to be very important in my view today to get glandless cotton production kicked off. Once glandless cotton production is rolling I presume markets will develop for glandless cottonseed products which will naturally lead to the establishment of incentives necessary to induce the farmer to plant glandless cottons instead of glanded cottons. What was your second question?

QUESTIONER: I just asked whether incentive would be different in different parts of the country.

DR. MIRAVALLE: I think that it would be.

QUESTIONER: What you just said was what I had in mind and you seem to agree that maybe there's not enough incentive right at the moment. That's what I have been driving at.

DR. MIRAVALLE: Yes. I'm in agreement with you, there isn't. We really don't have an overabundance of glandless seed to plant either.

COMMENT: It's premature to try to judge that.

DR. MIRAVALLE: Yes, I think we are kind of racing ahead of ourselves trying to anticipate a lot of things. This is all well and good, but we can get kind of warped in our thinking and at this time we need to stay as flexible as possible in order to meet our needs later on.

GLANDED COTTONSEED PROCESSING

by

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I plan to restrict my remarks to our development work with the Liquid Cyclone Process for producing edible cottonseed flour from glanded cottonseed. At the 17th Cottonseed Processing Clinic in 1968, Mr. Gastrock reviewed, in general, some of the Southern Utilization Research and Development Division's (SURDD's) work leading up to the conception of the Liquid Cyclone Process, presented a flow diagram outlining the process based on processing defatted flakes, and discussed the product with respect to quality and preliminary economic considerations. At last year's Clinic, Henry Vix (SURDD) presented data listing important characteristics and functional properties of meals and flours produced by the various extraction processes and included direct solvent extraction of glandless cottonseed and the Liquid Cyclone Process flour. The latter compared favorably with glandless cottonseed flour except for its slight yellow color. Since the last report the process has been modified and improved to process full-fat flakes (figure 1). The process now consists of taking the whole and cracked meats fraction, essentially hull free, from prime quality, uncontaminated cottonseed, drying them to approximately 3 percent moisture, flaking to 0.010 inch, preparing a fluidized slurry in hexane containing about 45 percent solids, and passing this fluidized slurry through a horizontal stone mill (0.003-inch clearance between stones) to detach the meat tissue from the pigment glands. The milled slurry is diluted with additional hexane to a solids content of about 20 to 25 percent and then pumped under an optimum pressure through a 3-inch-diameter stainless steel liquid cyclone to effect the separation of two fractions — an overflow fraction containing fine, high-protein flour essentially free of gossypol and an underflow fraction containing pigment glands, coarse meat particles with imbedded glands, and some hull particles. By filtration, washing to remove oil, desolventization, drying, and sterilization, a high quality cottonseed flour is recovered from the overflow slurry. The underflow fraction would normally exit the system, however, when washed free of oil and desolventized, the fraction analyzes as containing approximately 2.6 percent free gossypol, and 53 to 54 percent protein.

Until recently, because of equipment limitations, it has been necessary to collect the overflow from the Liquid Cyclone containing the fine solids and recover the flour by batch filtration.

With the above unit operations we have carried out five successful continuous runs in which about 7,700 pounds of cottonseed flakes were processed to produce approximately 1,700 pounds of high-quality edible flour all of which is to be used in a large-scale evaluation. This flour analyzed as the best ever produced in any quantity from glanded cottonseed having less than 1 percent lipids, 0.01 to 0.04 percent free gossypol, 0.04 to 0.10 percent total gossypol, 68 to 72 percent protein, and nitrogen solubility of 95 percent or better. This flour is bland, and the color is very light, creamy yellow. Information gained from these five continuous runs has enabled us to pinpoint phases of the process which might possibly be further improved.

In these runs we obtained yields on the order of 33 to 35 percent flour based on the weight of the solids input to the process. This, we feel, is low but we have gained quality at the expense of yield. We do believe, however, that the yield can be increased to enhance the economic desirability of the process. In our single milling operation we obtained about 50-percent fine and 50-percent coarse material. Projected yields that can be obtained by multiple milling the 45 percent slurry and by remilling the underflow from the liquid cyclone are shown in tables 1 and 2. In our single cyclone operation, we adjusted the split so that the overflow from the liquid cyclone would not have any microscopically detectable pigment glands in the flour. In doing this some of the fine material exited the system in the underflow. A sharp separation, such as the one we used, would not be necessary on a commercial scale, since two or more cyclones in series coupled with additional or improved milling would effectively increase yields.

The liquid cyclone used in early work was fabricated of porcelain. It was replaced with a stainless steel unit in order to eliminate static electricity buildup when higher feed pressures were used. The capacity of our 3 inch diameter stainless steel cyclone when fed with a 15 percent solids content slurry ranged from 480 pounds per hour of flour at 10 p.s.i. feed pressure up to 950 pounds per hour of flour at 40 p.s.i. feed pressure. The latter figure is equivalent to slightly over 10 tons per 24-hour day.

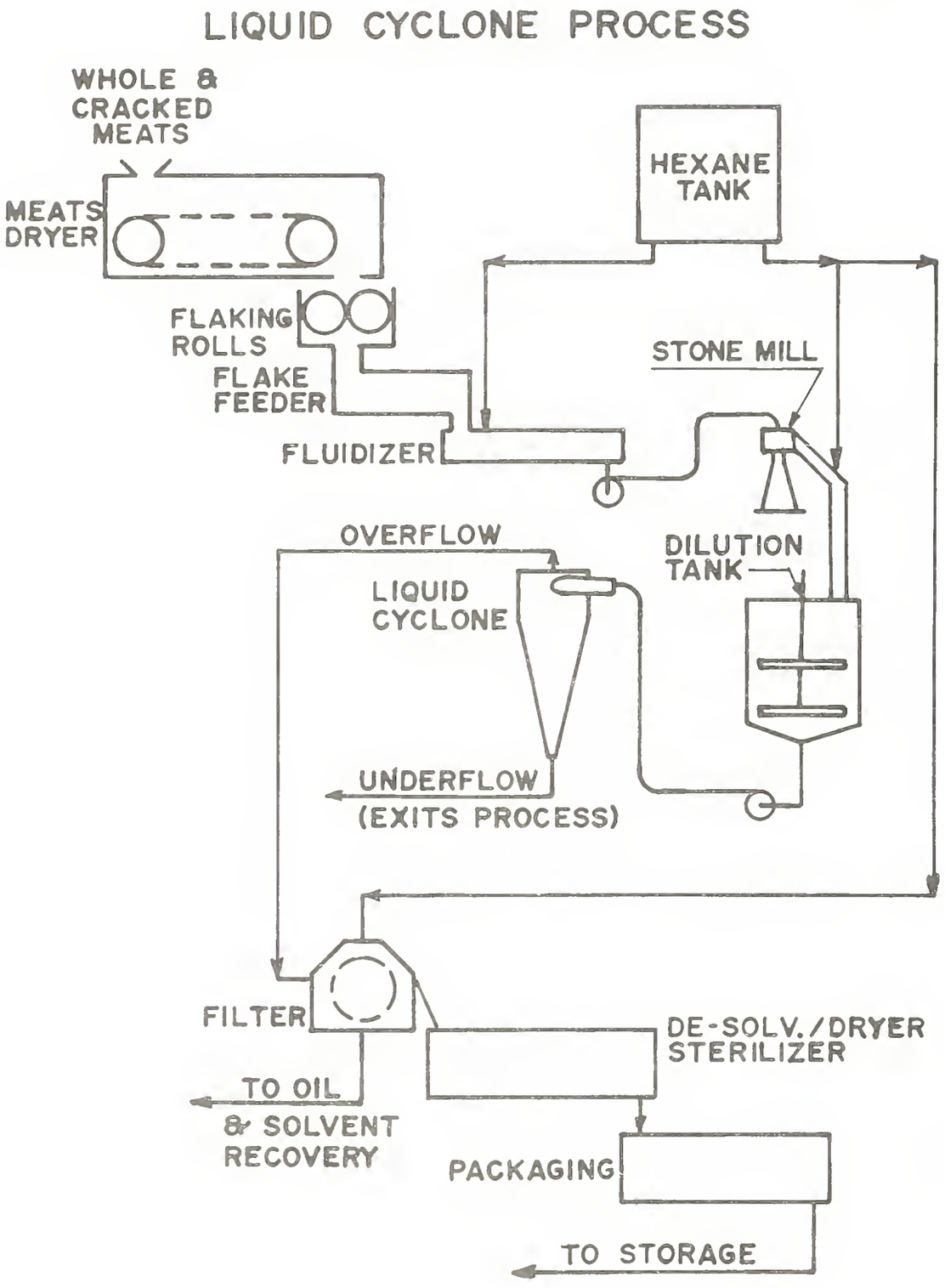

Figure 1. — Liquid Cyclone Process.

Table 1. — Effect of multiple milling

Number of passes[1]	Fines	Gossypol		Coarse
		Free	Total	
-	Percent	Percent	Percent	Percent
1	54.9	0.03	0.14	45.1
2	62.7	0.05	0.22	37.3
3	64.5	0.05	0.24	35.5

[1] Mill stone clearance — 0.003 inch.

Table 2. — Effect of remilling the liquid cyclone underflow

Material	Yield[1]	Analyses[1]		Protein
		Free gossypol	Total gossypol	
	Percent	Percent	Percent	Percent
Fines, original liquid cyclone unders	17.85	0.02	0.16	70.50
Coarse, original liquid cyclone unders	82.15	2.27	3.34	56.69
Fines, remilled liquid cyclone unders	39.86	0.03	0.26	66.87
Coarse, remilled liquid cyclone unders	60.14	2.07	4.39	53.79

[1] Moisture-free basis. Stone mill clearance 0.004 inch.

Passing the remilled unders through a second cyclone would increase the yield of flour from about 37 to 44 percent based upon the input solids to the plant — almost a 19 percent increase.

The lower the feed solids concentration to the liquid cyclone, the higher the possible yield of recovered flour. This is shown in the figure 2. Take for example, when milling has produced 50 percent fines and 50 percent coarse disintegration of the flakes, the solids concentration of the feed to the cyclone is 10 percent and the underflow of the cyclone is regulated at 45 percent solids. Then we should recover 46 percent of the input solids as fine flour. However, when the solids feed to the cyclone is increased to 25 percent with the same degree of milling, then we would only recover 37 percent of the feed input as fine flour. You can also see the effect of disintegration of the meats on the recovery of fine flour. As the ratio of fine to coarse fraction increased, the possible fines recovery for a given solids concentration in the feed to the cyclone increases. Again, note that the lower the feed solids concentration to the cyclone, the higher the yield of flour possible. This presents a problem for which the solution is a compromise, because as the possible yield of product increases with the lower feed solids concentration to the cyclone, the solvent to solids ratio also greatly increases and therefore, raises the cost of recovery of solvent and oil. This is shown by the fact that the solvent to meats ratio to produce a 10-percent

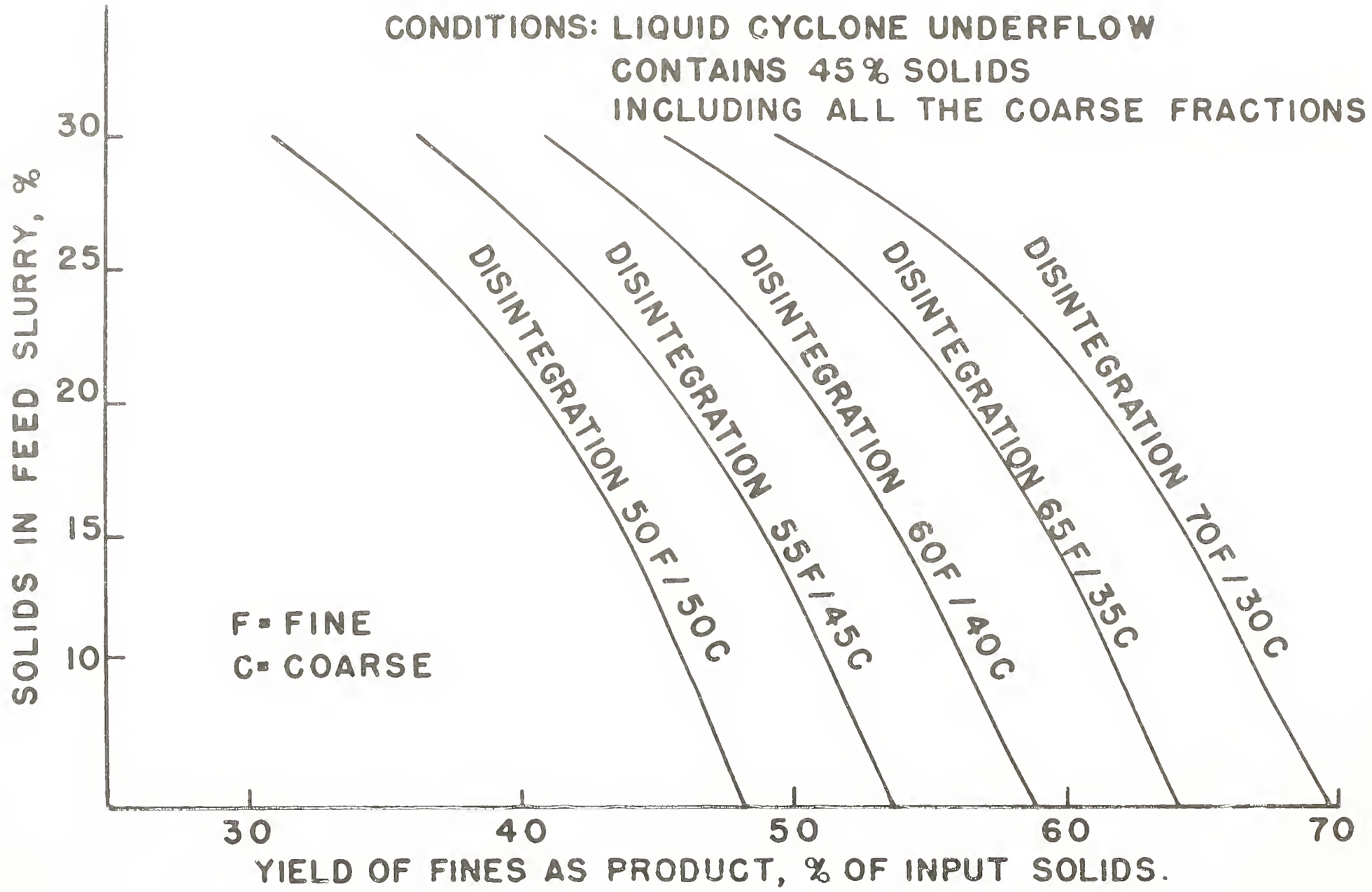
CONDITIONS: LIQUID CYCLONE UNDERFLOW
CONTAINS 45% SOLIDS
INCLUDING ALL THE COARSE FRACTIONS
SOLIDS IN FEED SLURRY, %
30
25
20
15
10
DISINTEGRATION 50F/50C
DISINTEGRATION 55F/45C
DISINTEGRATION 60F/40C
DISINTEGRATION 65F/35C
DISINTEGRATION 70F/30C
F = FINE
C = COARSE
30
40
50
60
70
YIELD OF FINES AS PRODUCT, % OF INPUT SOLIDS.

Figure 2.

solids slurry is 5.7 to 1 and the miscella to be recovered would contain about 5.7 percent oil, whereas the solvent to meats ratio needed to produce a 25-percent solids slurry is only about 1.7 to 1 and the miscella concentration is about 16.7 percent. We haven't investigated the economics of this but presently, for another reason, we lean toward a slurry feed to the cyclone of 25-percent solids in order to produce a 15- to 16-percent solids in the cyclone overflow. At this concentration it can be fed directly to a continuous vacuum filter. At lower than about 15-percent solids, an additional concentration step would be needed, maybe one or more stages of 10-mm. diameter cyclones, or an appropriately designed evaporator; in any case, more complications and more equipment.

As mentioned earlier today, Dorr-Oliver, Inc., now has a pilot-plant in operation at the Sunddatta Oil Mill, Hubli, India, to produce about 2 tons per day of flour which will be test-marketed in India under an Agency for International Development (AID) contract. This pilot-plant is based on information developed at the Southern Utilization Research and Development Division on the Liquid Cyclone Process using full-fat flakes.

We envision the Liquid Cyclone Process in the United States would at first be a small installation producing 8 to 10 tons of flour a day. It is further envisioned that such a plant would be operated as an adjunct to a large solvent extraction plant that now produces oil and feed-grade meal. The operations of the satellite liquid cyclone plant would use whole and cracked meats essentially free of hulls from the parent plant, and the coarse fraction underflow from the cyclone would be returned to the extraction system of the parent plant. The liquid cyclone plant would require sanitary conditions comparable to those used in the food industry. Under the above-cited conditions, we believe that the operations of the Liquid Cyclone Process would require the minimum of labor, and all other operating costs would be nominal. This means that it may be possible to have a production cost for the flour that may not exceed 8 to 10 cents per pound for a plant operating 200 days per year.

GLANDLESS COTTONSEED PROCESSING

by

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During the past 4 years there have been rapid developments in the production and processing of glandless cottonseed. While many bench and pilot plant-scale processing studies were conducted prior to 1966, the first large-scale attempt to process glandless seed in a commercial oil mill was realized in 1966. Garlon Harper reported at the 1967 Cottonseed Processing Clinic results of this 40-ton extraction of glandless seed at the Leland Oil Works in Leland, Miss. A brief review of the product produced and feeding studies conducted appears to be in order. The product produced at Leland Oil Works contained:

	Pct.		Pct.
Moisture	8.3	EAF Lysine	3.65
Crude protein	46.3	N-solubility	84
Fat	2.4	Gossypol-Free	0.009
Fiber	11.2	Gossypol-Total	0.042

This meal was light tan in color with an excessive amount of hull particles present. Extensive feeding studies were conducted with broilers, layers, and swine. The results may be summarized that the meal was equal or superior to soybean meal in the practical rations tested when included as a portion of the supplemental protein. Upon complete replacement, supplemental lysine was needed for optimum performance.

The next large scale processing of glandless seed occurred in 1967 at the Plains Cooperative Oil Mill in Lubbock, Tex. Six hundred tons of 'Gregg 25V' glandless seed were extracted using essentially conventional crushing operations. The only significant change from normal operations was that the mill throughput was reduced by about half capacity. This change doubled the retention time in the extractor and DT unit. The extracted flakes were milled and passed over a 20-mesh vibrating screen. The throughs analyzed:

	Pct.		Pct.
Moisture	8.0	EAF Lysine	3.66
Crude protein	52.8	N-solubility	80
Fat	2.9	Gossypol-Free	0.01
		Gossypol-Total	0.02

The heat incurred during desolventization produced a product with a "toasted" brown color. Biological testing indicated that the meal was of superior quality.

About a month after the Lubbock crush an article entitled "White Cottonseed Flour — A New Low Cost Protein Source" appeared in a food trade publication. This article was responsible for an avalanche of requests for this new product. It should be pointed out that the product referred to in this popular article was a pilot plant processed flour which was desolventized by air drying. The air drying got around the browning reaction which is responsible for color formation and protein damage which occurs due to excessive heat in desolventization.

A joint effort between the Southern Utilization Research and Development Division (SURDD) and the National Cottonseed Products Association, Inc. (NCPA) was initiated to supply the food industry with samples of the pilot plant processed "white" flour and the Lubbock meal. It was soon evident that the food industry was extremely interested in obtaining a low-cost, functionally-active, bland-flavored, light-colored cottonseed flour. The Lubbock processed glandless meal lacked the functionality and color criteria demanded.

The interest shown in the laboratory-processed flour promoted a series of trial extractions at the Crown Iron Works Pilot Plant in Minneapolis, Minn. The results obtained showed that a product of value to the food industry could be produced in a commercial pilot plant using a Schneckens tube for desolventization. The product produced was light-colored, the protein was not denatured, and the flour was available for upgrading by air-classification or protein isolation procedures.

The next bit of history occurred last year at the Processing Clinic when Al Hazelton, Manager of Producers Cooperative Oil Mill, Oklahoma City, Okla., agreed to purchase 200 tons of 'Watson GL 16' glandless cottonseed from Rogers Delinted Cottonseed Company of Waco, Tex. The Oklahoma City mill was ideal for the experimental crush since it had the capability to desolventize without the addition of live steam which denatures the protein and limits food end use flexibility.

A joint project was set up between equipment manufacturers, SURDD, Texas A&M, and NCPA with the objective to determine the adequacy of a commercial oil mill to produce a glandless cottonseed product with characteristics of value to the food industry. Of particular interest was whether it was possible, on an oil mill scale, to desolventize spent flakes at a low enough temperature to remove all traces of solvent and yet not denature the native cottonseed protein.

Producers Cooperative Oil Mill completed their 1968-69 cottonseed crush, made maintenance repairs, cleaned the mill inside and out, and on October 27 and 28, 1969, crushed the 200 tons of glandless cottonseed.

The mill tonnage throughput was reduced from 250 to 125 to allow for desolventization in the DT unit without the addition of live steam. The glandless seed had been stored for about a year and the moisture was down to 5.5 percent. The dry seed generated considerable fines in the dehulling operation. Conventional cottonseed delinters, dehullers, and hull separators were used. The meats were conditioned in a seven-high stack cooker. Water was added in the top ring to bring moisture up to 8.5 percent. The temperature of the meats out of the conditioner was about 170°F.

The meats were then flaked in a Bauermeister flaker to a flake thickness of 0.010 to 0.012 inch. Some difficulties were experienced since the flakes in the middle of the rolls were running up to 0.015 inch. This caused a little higher residual lipid in the meal.

The flakes were sent to a Crown 250-ton extractor which was running at half speed. No special difficulties were encountered. Drainage was good despite the amount of fines. From the extractor, the flakes were conveyed by a Crown steam-jacketed conveyor screw to the DT which was a Crown five-tray, 102-inch-diameter toaster. The construction and temperature gradient in the steam-jacketed conveyor screw aided desolventization.

Initially, full 150 p.s.i. steam pressure was maintained in the top 3 trays of the DT unit to raise the temperature of the spent flakes to where the hexane could be flashed off. Steam to the fourth and fifth trays was turned off. The fourth tray gate was held open so the meal dropped right through that tray. Thermometers had been installed in the door of each tray about 7 to 8 inches from the tray bottom and temperatures were recorded. During the early stages of the run a maximum temperature of 180°F. was maintained. At this temperature the meal came out of the DT dark, and protein solubility damage was suspected.

It was then determined that the maximum temperature in the DT unit should be dropped to the point where either solvent was detected in the meal or the colored product hoped for was obtained.

This procedure took quite some time because of the slow response of each change. Eventually the third tray steam virtually was turned off, and the second tray steam was cut down to 50 p.s.i. After about 12 hours of running, the system settled down and the discharge temperature at the DT was brought down to 150°F. The temperatures in the five trays at this point were from the top:

Tray No.	Temperature	Internal tray steam pressure
1	142°F	150 p.s.i.
2	142°F	50 p.s.i.
3	146°F	0 to 5 p.s.i.
4	Open	0 p.s.i.
5	152°F	0 p.s.i.

From this point on, temperature was maintained at 143° to 145° in the third tray, and 147° to 149° out of the fifth tray. For the remainder of the run, a desirable meal was obtained as far as color was concerned.

From the DT the meal went through a screw conveyor to a pneumatic meal-cooler conveyor system. It was discharged into a Carter-Day cyclone and the air pulled through the fan and discharged to the atmosphere. Because of the light, dry, fluffy type meal, a portion of the fine flour was discharged with the air. Samples of dust from the cyclone contained in excess of 70 percent protein on a dry weight basis.

The meal was screened over a 12-mesh screen to obtain two fractions:

	"Throughs"	"Overs"
	Pct.	Pct.
Moisture	8.5	9.1
Crude protein	44.8	26.9
Fat	3.2	1.6
Fiber	6.8	23.0
N-solubility	97	90

The throughs were shipped to Ralph Woodruff's plant at Wilson, Ark. Delta Products Company turbo-milled the flakes and screened over a 60-mesh screen. The yield was about 75-percent throughs. The flour produced had the following analyses:

	Pct.		Pct.
Moisture	9.5	Fiber	3.3
Crude protein	54.7	N-solubility	96
Crude protein (DWB)	60.8	Gossypol-Free	0.04
Fat	2.4	Gossypol-Total	0.06

This product is being evaluated by several food processing companies.

So, where do we go from here?

(1) We know we can produce a glandless cottonseed meal of a nutritional value superior to products merchandised today.

(2) We know that we can produce an undenatured protein in a commercial oil mill.

(3) We know that research is still needed in assuring complete hull removal, adequate sanitation, access economies of production, and marketing of glandless products. These areas of concern may be easily solved if needed.

Our biggest problem today is a sufficiently optimistic outlook for glandless seed production to assure processors the supply of raw material needed to produce a competitive flour product. To be optimistic about the prospects of a commercially available glandless cottonseed flour, being marketed in the near future, there must be a supply of glandless cottonseed available and the processing cost, including raw material cost, must not be excessive. The end use markets are there if we can produce a competitive product.

I would like to take this opportunity to express our appreciation for the tremendous cooperation we have received from several concerns. It is just about impossible to give each of them the credit deserved. Success would not have occurred without complete cooperation from the three oil mills (Leland Oil Works, Plains Cooperative Oil Mill, and Producers Cooperative Oil Mill), equipment manufacturers/suppliers (Crown Iron Works, N. Hunt Moore and Associates), SURDD, Texas A&M, and many other organizations which have so freely given their time and advice to accomplish the tremendous advances which are now history.

DISCUSSION

QUESTION: Did I understand you to say you had gotten 75-percent recovery in protein during this process?

DR. SMITH: Spent flakes, after passing over a 12-mesh screen, were analyzed to contain approximately 50-percent protein on a dry weight basis. These flakes were turbo milled to aid hull removal. The milled flakes were passed across a 60-mesh vibrating screen; the yield was 75-percent throughs which analyzed approximately 60-percent protein on a dry weight basis. Approximately 80 to 85 percent of the protein was recovered in the throughs or flour portion.

QUESTION: You said thrust or overs?

DR. SMITH: Thrust.

QUESTION: Did you make any analysis on the oil produced at that time?

DR. SMITH: No, we did not obtain data on oil characteristics. However, the glandless oil was miscella refined with no particular problems occurring.

QUESTION: What about the bleach — color of the oil?

DR. SMITH: This was not determined.

QUESTION: Did you calculate the hull content of the flakes going through the extractor? Do you know what this was, percentage wise?

DR. SMITH: From rough calculations it appeared that between 5- to 10-percent hull material was in the flakes going to the extractor. This may, in the future, be excessive, but in this trial it was thought necessary in order to allow for proper drainage.

QUESTION: What did you say was the free and total gossypol?

DR. SMITH: The free gossypol was 0.04 and the total gossypol was 0.06 for this particular variety. These seeds were a little bit higher in free gossypol than we had seen in the past.

QUESTION: You have recognized the importance of nitrogen solubility and, of course, this is extremely important to those of us in the food industry. How do you run that protein determination?

DR. SMITH: Nitrogen solubility is determined in cottonseed products by calculating the amount of nitrogen which is soluble in 0.02 normal sodium hydroxide. This measurement is not the same as dispersible protein or nitrogen solubility in soya products.

COTTONSEED PROTEIN ISOLATES – PREPARATION, COMPOSITION, AND USE[1/]

by

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(Presented by W. H. Martinez)

The food industry of the United States has recently delineated a notable change in the food habits of our population. A large segment, primarily the teenage group, has shifted from three to five meals a day with one out of every three of these consumed outside the home (8). This change, as well as a number of other significant factors, such as the increase in the number of women working outside the home has created a need for quick, conveniently prepared foods and snack items. The food industry, in its efforts to meet this need and the need for good nutrition, has also recognized that many of our more familiar traditional foods are rigidly bound by standards of identity which tend to inhibit processing and product changes, irrespective of motivation (4). These conditions are inducing a new era in the food industry — an era in which food formulation, rather than food modification, may well be the dominating process.

The present and expanding interest of the food formulator in plant proteins is due to two major factors: (a) low cost per unit of protein, and (b) constant supply of raw material. The rate at which plant proteins enter food markets will be limited only by the ability of these products to meet the unique functionality, taste, and color requirements of the food industry.

Three major classes of plant protein products are flours, concentrates, and isolates. The protein content is the major distinguishing factor. The isolate, generally 90-percent protein (dry weight basis, DWB) or better, is usually prepared from hexane-defatted oilseed meal or flour. One might well ask, "Why, at additional cost, make an isolate? Why not use the flour at 60-percent protein (DWB) or the concentrate at 70-percent protein (DWB)?" The answer is a very basic one.

The food formulator will utilize the protein product which provides the most advantageous compromise between end-use functional requirements and cost.

In many instances the formulation requirements can only be met by the isolate. The use of soy products in comminuted meats is an interesting illustration of this situation. If the protein product is to be used merely as a filler or to retain juices in the comminuted meat, then soy flour or grits will meet the need at low unit cost. Apart from legal regulations, the major limitations on the quantity of flour used in the meat are the taste and mouthfeel imparted to the finished product. These limitations can be reduced, at a cost, by using the blander soy protein concentrate. However, if the processor desires to extend or replace the high-cost, highly functional muscle proteins in the meat product, only the protein isolate can be used to meet the functional needs of the product formulation. The extent of replacement will be determined by the comparative costs of the plant and muscle protein. Presently, the neutralized soy isolate, the product with maximum functionality, is the one most widely used in the comminuted-meat industry (9).

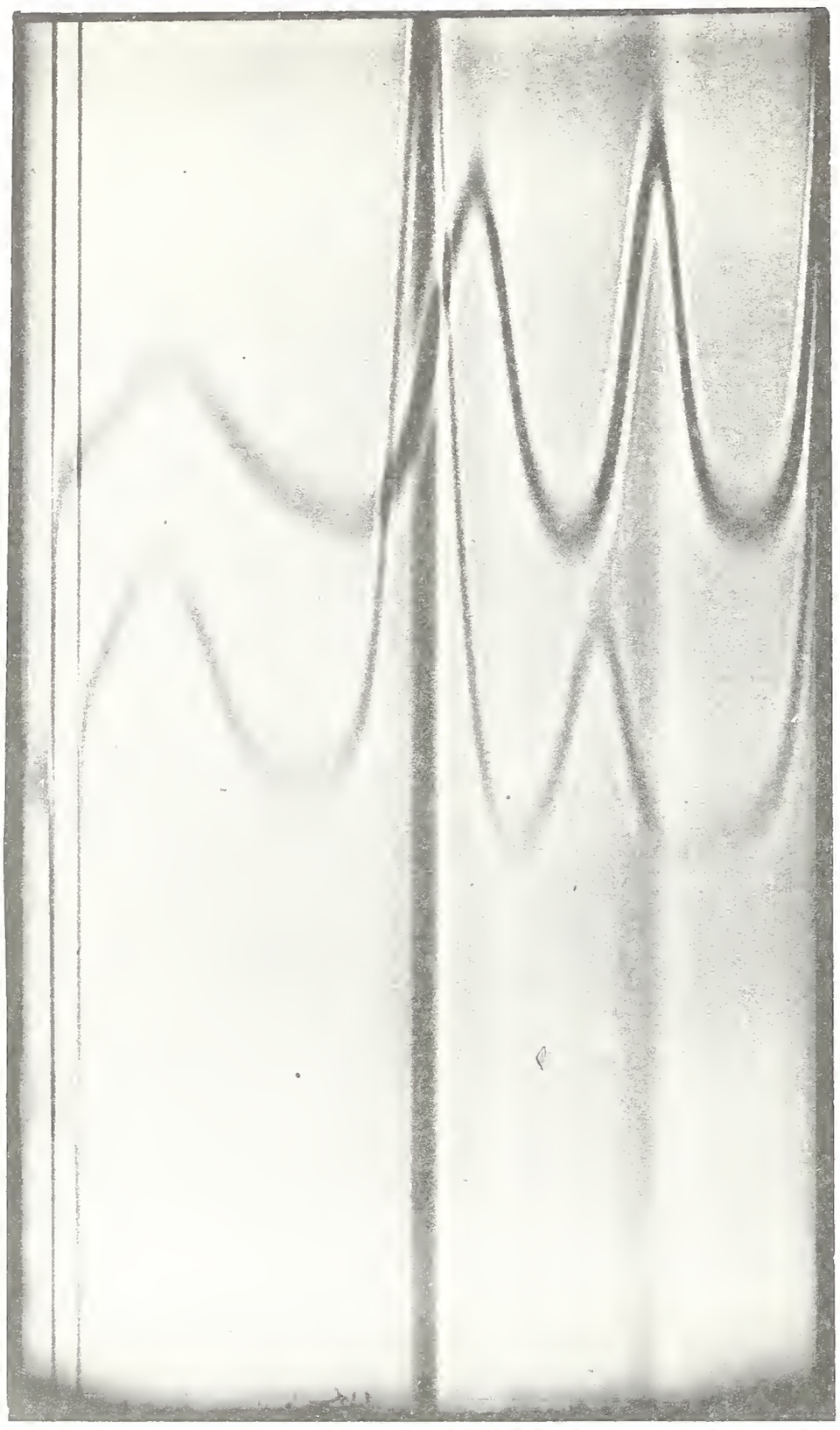
The functionality of a protein isolate is dependent upon the following factors: (I) The amino acid composition and sequence in the proteins, (II) the number and type of proteins in the isolate, (III) the number and type of nonprotein constituents in the isolate, (IV) the ionic charge on the isolate, and (V) the ionic environment of the end-use formulation.

The first factor — the amino acid composition and sequence in the protein — is determined by the type of seed, for example, soy or cotton, and by the function of the protein in the seed. Proteins serve three major functions in the seed. First, they are part of the structural elements of the cell, that is, the cell wall and various membranes. Second, they are part of the working machinery of the cell — the various enzymes and components that keep the cell alive. Third, they are part of the food stored by the cell for the development of the new plant.

The amino acid composition and molecular weight of the structural proteins will vary with the type of protein complex found in the particular structure. The extractability of this type of protein is also dependent on the nature of the complex. Certain of these proteins cannot be extracted except by hydrolysis of the structural component.

The working-machinery proteins are usually low in molecular weight and are water dispersible. These proteins in the cottonseed are about ten in number and, collectively, are high in the nutritionally important amino acids lysine, cystine, and methionine (7).

[1/] This work has been supported in part by the National Cottonseed Products and the Foundation for Cotton Research and Education.



Ultracentrifuge patterns of alkaline extracts of defatted soybean and cottonseed flours. Upper-soybean extract (.027M NaOH, lg:15ml) dialized against standard phosphate buffer pH 7.6, 0.5 ionic strength, 0.01M mercaptoethanol. Lower--cottonseed extract (.027M NaOH, lg:15ml) dialyzed against 0.2M Na_2CO_3-$NaHCO_3$ buffer pH 10.5. Analytical rotor at 59,780 r.p.m. with standard and wedge quarts cells, 60 minutes past top speed. Sedimentation from left to right.

Figure 1.

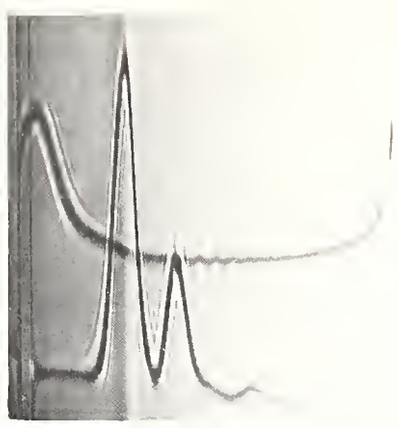
The storage proteins found in the protein bodies of the cell are usually high in molecular weight and may or may not be water dispersible. In the soybean and peanut they are water dispersible; in the cottonseed they are not. Alkaline conditions are needed to extract the storage proteins which are few in cottonseed, relatively low in lysine and the sulfur amino acids, and high in arginine and phenylalanine (7).

Since both cottonseed and soybean seeds store oil and protein, some similarity in the types of their proteins might be expected. Based on genetic and amino acid differences, some diversity between the types of their proteins might also be expected. In terms of the average molecular weight, this is exactly what is found. The ultracentrifuge patterns of alkaline extracts of cottonseed and soybean are shown in figure 1. The extracts contain about 90 percent of the nitrogen of each of the seeds. The ultra-centrifuge pattern gives a qualitative picture of the molecular weight of the species in the extract. The higher the molecular weight, the faster the protein sediments and, as in this picture, the farther to the right it will appear. The proteins from each extract divide into three major areas. In this respect they are similar. However, the relative proportion in each area is different. The soybean is richer in the higher molecular weight proteins, the cottonseed in the intermediate group.

Genetics, therefore, is the major determinant of the first factor. The second and third factors governing functionality — the number and type of protein and nonprotein constituents in the isolate — are determined by the methods of extraction and precipitation that are used to obtain the isolate. If we acidify these alkaline extracts to achieve maximum precipitation of the nitrogen and examine the precipitated proteins in the ultracentrifuge, we again see the same difference in the relative proportion of the higher molecular weight proteins. There is also another difference. In order to achieve maximum precipitation, the soy extract must be acidified to pH 4.5 (10). Maximum precipitation of the cottonseed proteins is achieved at pH 5 (3).

This procedure can be called the classical method for the preparation of protein isolates — maximum extraction of the nitrogen followed by maximum precipitation. Such a product will contain proteins from all three types — structural, working machinery, and storage — as well as the nonprotein constituents which are coprecipitated.

With the cottonseed, however, we know that at least two of the types of proteins can be separated by the method of extraction. If we extract the defatted cottonseed flour with water, we remove the water-soluble, machinery proteins of the seed — the low molecular weight components seen in the upper portion of figure 2. These proteins represent 25 to 30 percent of the total nitrogen of the seed. Re-extraction with alkali will solubilize the storage proteins of the seed — the major



Ultracentrifuge patterns of successive water and alkaline extracts of defatted cottonseed flour. Ratio lg:15 ml. Upper--water extract. Lower--alkaline extract (0.2M Na_2CO_3-$NaHCO_3$ buffer, pH 10.5). Analytical rotor at 59,780 r.p.m. with standard and wedge quarts cells. Sedimentation from left to right.

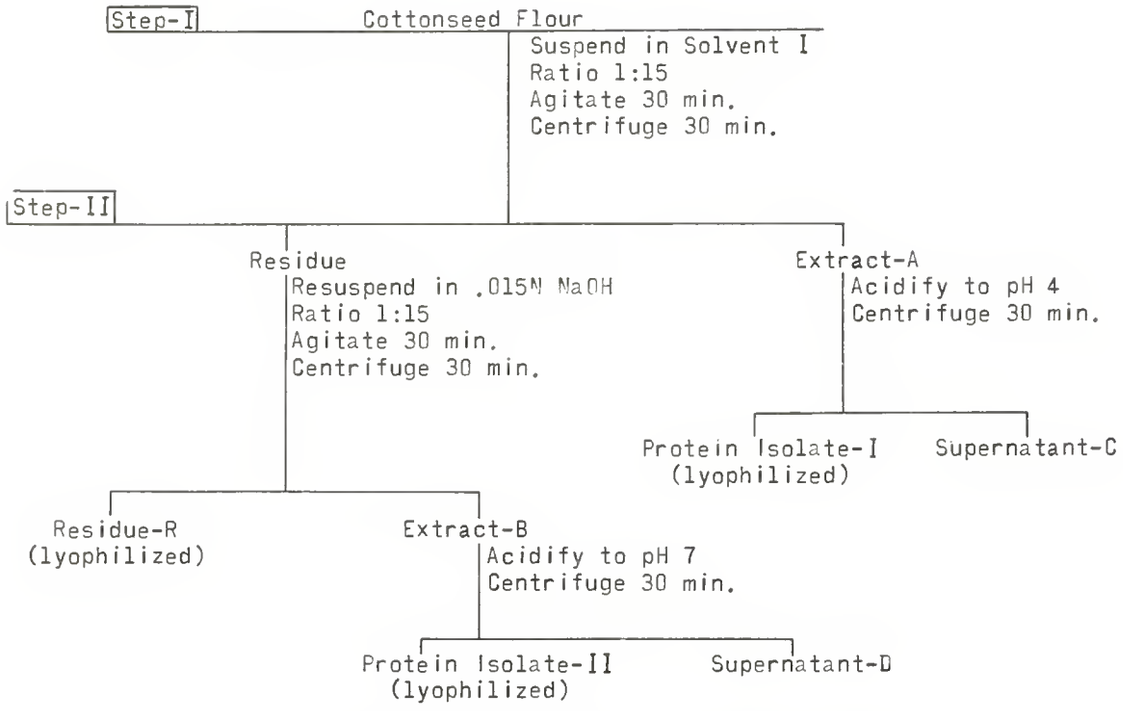
Figure 2.

portion of the protein (figure 2). In addition to the separation of the proteins, a separation of the nonprotein constituents is also achieved. By extracting first with water, not only are the low molecular weight proteins removed but the water-soluble phosphorus components, and color bodies are extracted.

Based on this difference in the extractability of the proteins of the cottonseed, we developed what is called the two-step selective extraction procedure (figure 3) (1). You will note that in this procedure maximum precipitation of the water soluble, low molecular weight proteins is achieved at pH 4 while the major storage proteins are precipitated at pH 7.

This process can be used with undenatured flour from glandless or glanded cottonseed varieties and particularly with the Liquid Cyclone flour (5). Though, with the flours from glanded cottonseed the pigmentation and yield of Isolate I make the economics of recovery questionable. Isolate II, the major isolate, however, has been obtained in excellent yield from Liquid Cyclone Flours prepared by the Engineering and Development Laboratory at the Southern Utilization Research and Development Division. This isolate is comparable or higher in nitrogen content than the glandless isolate and averages 0.07 percent total and 0.01 percent free gossypol.

A comparison of the results obtained from glandless flour with the classical single-step extraction and the selective two-step extraction procedures shows that the isolates differ not only in number and type of proteins but also in protein and nonprotein content (table 1). In addition to the differences in phosphorus content, noted in table 1, single-step isolate contains about half as much total sugar as the low molecular weight isolate, Isolate I, and the major isolate of the two-step procedure, Isolate II, has none.



Flow diagram of the two-step, selective extraction procedure for the preparation of cottonseed isolates.

Figure 3.

Table 1. — Cottonseed isolate preparation: Comparison of single and two-step extraction procedures

Procedure	Extract			Isolate[1]			
	pH	Percentage of total N extracted	pH of precipitation	N	P	Percentage of total N	Percentage of total wt.
				Percent	Percent		
Single-step[2] [3]							
.027N NaOH	9.85	82.8	5.0	14.90	0.90	62.8	39.2
Two-step[2] [3]							
Step I							
H_2O	6.70	25.9	4.0	13.38	3.47	16.1	11.2
Step II							
.015N NaOH	9.78	59.8	7.0	16.05	0.47	52.6	29.8

[1] "As is" basis.
[2] Extraction conditions: Ratio-1:15; Time-30 min; Temperature-25°C; glandless flour.
[3] Average of 4 trials from Acala and Gregg 25V glandless flours.

The differences in amino acid composition between the isolates can be seen in table 2. The single-step isolate has an amino acid composition very similar to the original flour.

Table 2. — Amino acid composition of cottonseed flour and isolates

Amino acid	Glandless Flour (Acala) g/16gN	Isolate I g/16gN	Isolate II g/16gN
Lysine	4.3	6.0	3.0
Histidine	2.8	2.6	3.0
Arginine	12.1	10.4	11.3
Aspartic	8.8	6.7	8.4
Threonine	3.0	2.9	2.7
Serine	4.0	3.4	4.5
Glutamic	19.8	21.8	18.9
Proline	3.5	3.1	3.1
Glycine	4.0	3.2	3.7
Alanine	3.6	3.2	3.5
Valine	4.5	3.3	4.4
1/2 Cystine	-	2.6	0.3
Methionine	1.2	1.7	1.0
Isoleucine	3.3	2.6	3.1
Leucine	5.6	5.1	5.8
Tyrosine	3.0	3.3	2.6
Phenylalanine	5.3	3.7	6.3

On the basis of the differences in amino acid composition and the pH of maximum precipitation, it is not expected to find differences in the solubility characteristics of the isolates (figure 4). The solubility of an isolate is one indication of the basic functionality of an isolate.

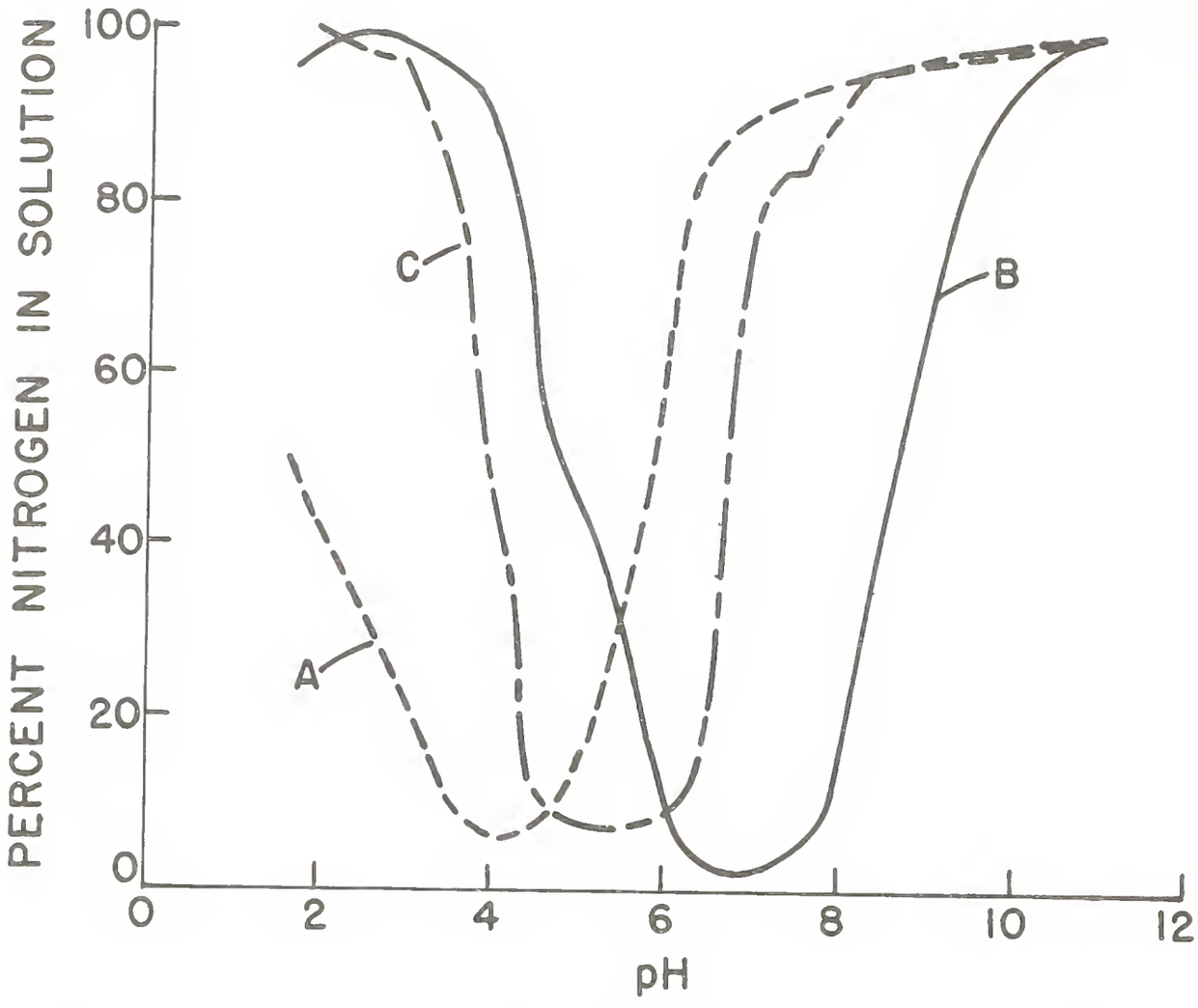
The wide difference in the pH of precipitation of the two major groups of proteins suggested that rather than selective extraction, it might be possible to separate the two groups by selective precipitation. That is, perform a single alkaline extraction and, rather than a single precipitation at pH 5, conduct a double precipitation. Precipitate and collect the proteins insoluble at pH 7 and then further acidify the extract to pH 4 to obtain the low molecular weight proteins. The separation achieved by this procedure is excellent and the yields are comparable. But the nonprotein complement of the isolates is different and affects both the purity and solubility characteristics of the isolates. The high molecular weight isolate is lower in nitrogen because the complex carbohydrates which are solubilized in the single alkaline extract coprecipitate at pH 7. The solubility of the isolate at pH 4 now appears much more like that of the single-step isolate (Curve C., figure 4), and the general solubility of this low molecular weight isolate is greatly reduced. This reduction is probably due to interactions between the proteins and the now highly charged nucleic acid and other soluble phosphorus compounds. In the two-step procedure these compounds are removed in the water extract and never achieve a charge environment above pH 7.

The composition of the cottonseed isolate will, therefore, depend upon the particular method of preparation. Once prepared, however, the charge on the protein molecule and the ionic charge environment in the end-use product will determine the ultimate functionality — factors IV and V. The point of neutral charge on the protein molecule, when there are neither excess positive or excess negative charges, usually coincides with the point of minimum solubility of the isolate. For this reason the net change on the isolate is usually increased.

Changes in the charge on the storage proteins in Isolate II result in a very interesting phenomenon called dissociation. The proteins, which have a relatively high molecular weight in alkaline solution — about 180,000, dissociate in acid solution to units having a molecular weight of less than 50,000. Because of this dissociation, it is possible to prepare 6-percent solutions of the isolate in citric acid which would be wholly compatible with the acidity of a citric acid base soft drink. Other plant protein isolates, unless chemically or enzymatically modified, would precipitate under these conditions.

The term "functionality" has many facets. It includes the basic functionality of an isolate, the determinants of which we have just discussed. It also includes the end-use functionality, i.e., those characteristics, determined by empirical research, which produce the desired effects in the final product. Whipping agents are a good example of this. It is known that low molecular weight proteins make good whipping agents. When we examined the low molecular weight isolate for whippability, we found that it possessed an unusual whippability at acid pH (2).

There is also a negative facet to functionality. In certain end-uses such as supplementation of bread to improve the nutritive value, the protein should not interfere with the structure of the end product. When



Nitrogen precipitation curves of 1 per cent solutions (pH 10.5) of isolates from the two-step and single-step extraction procedures. Curves A--Isolated I, two-step extraction; Curve B--Isolate II, two-step extraction; Curve C--Isolate from single-step extraction. pH values taken after centrifugation.

Figure 4.

cottonseed flour, cottonseed concentrate, and cottonseed isolate are substituted for flour in a sponge and dough formulation at the 10-percent level, only the isolate produced an excellent loaf and did not disrupt the structure of the bread (6). Even when substituted in a continuous-mix formulation at low levels to provide water absorption and resistance to staling, the low molecular weight isolate, Isolate I, interfered with the shape and the grain of the loaf while the major high molecular weight isolate outperformed the nonfat dry milk and soy controls.

This same low molecular weight isolate, when heat denatured, can be introduced into the formulation without affecting the structure. However, the isolate is no longer used for functional or nutritional reasons but for the cheeselike flavor which it imparts to the loaf.

What, then, is involved in the commercial preparation of an isolate and how do you as processors fit into this picture? A major consideration is a constant supply of undenatured, defatted flakes or flour. In present commercial operations, the solvent extraction plant is usually located adjacent to the isolate plant. Isolate processes are simple in principle but sophisticated in practice and involve a number of considerations such as: (a) the type of centrifuging operation applicable to the method and material; (b) the efficiency of the centrifuging operation in terms of both the number of centrifuging operations and the recovery; (c) the method of drying the isolate which may well influence the final functionality; (d) the bacteriological control needed throughout the process; and (e) the pollution control. Each of these aspects is involved in the cost of production.

It will take, therefore, a highly skilled labor force to run such an operation. Perhaps, at this time, the most logical place in the isolate process for you, the oilseed processor, is the important role of supplier of the raw materials, the undenatured, defatted flakes. No matter how unique the isolate procedure or how interesting the functionality, the isolate cannot be made without the raw material. If you do not choose to take this role, you may find a new competitor in the field for seed — the food formulator who will crush his own seed to produce protein products that will meet his needs and specifications.

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Figure 1. Ultracentrifuge patterns of alkaline extracts of defatted soybean and cottonseed flours. Upper-soybean extract (.027M NaOH, lg:15ml) dialized against standard phosphate buffer pH 7.6, 0.5 ionic strength, 0.01M mercaptoethanol. Lower — cottonseed extract (.027M NaOH, lg:15ml) dialyzed against 0.2M Na_2CO_3-$NaHCO_3$ buffer pH 10.5. Analytical rotor at 59,780 rpm with standard and wedge quarts cells, 60 minutes past top speed. Sedimentation from left to right.

Figure 2. Ultracentrifuge patterns of successive water and alkaline extracts of defatted cottonseed flour. Ratio lg:15 ml. Upper — water extract. Lower — alkaline extract (0.2M Na_2CO_3-$NaHCO_3$ buffer, pH 10.5). Analytical rotor at 59,780 rpm with standard and wedge quarts cells. Sedimentation from left to right.

Figure 3. Flow diagram of the two-step, selective extraction procedure for the preparation of cottonseed isolates.

Figure 4. Nitrogen precipitation curves of 1% solutions (pH 10.5) of isolates from the two-step and single-step extraction procedures. Curves A — Isolated I, two-step extraction; Curve B — Isolate II, two-step extraction; Curve C — Isolate from single-step extraction. pH values taken after centrifugation.

DISCUSSION

QUESTION: Have protein quality studies been run on Isolate II?

MRS. MARTINEZ: We have not run PER's on Isolate II. However, the amino acid analysis would seem to indicate that lysine would be the first limiting amino acid. We have substituted this product for wheat flour at various levels in a bread formulation and have determined the protein quality of the bread by three procedures: PER (Protein Efficiency Ratio); NPU (Net Protein Utilization); and RNV (Relative Nutritive Value). The bread with cottonseed isolate at 3 percent is comparable to the 3-percent nonfat dry milk control. With 15-percent substitution, the bread produced a large increase in weight, but the protein quality was not improved. At a 10-percent level of substitution, the bread still has the characteristics of a white loaf of bread. At 15 percent, the loaf assumes the characteristics of a high protein bread.

QUESTION: Then, we would assume you do not have PER values for the other two isolates?

MRS. MARTINEZ: This is true. We do not have values for either. You can, however, estimate the deficiencies of each fairly well from the amino acid analysis. The single step isolate should have an amino acid composition similar to that of the cottonseed flour. PER studies on the cottonseed flour have given values of 2.3, 2.4, and 2.5 when casein is adjusted to 2.5.

QUESTION: Do you have any data on heat stability at low pH?

MRS. MARTINEZ: A 6-percent solution of the major acid soluble isolate, Isolate II, in 0.2M citric acid can be boiled without producing precipitation. Heat enhances the solubilization.

The minor isolate, Isolate I, has an interesting history. Normal commercial operations include a wash of the isolate during preparation. If we wash Isolate I at pH 4.8 rather than pH 4 (the pH of precipitation), we remove about 10 percent of the nitrogen but also about one-third of the phosphorus. After such a wash the isolate is no longer heat denaturable at 70°C.

QUESTION: Do you have any idea of the breakdown of raffinose in these various steps?

MRS. MARTINEZ: I do not believe that raffinose is a major contaminate of the isolates. Isolate I does have a measurable lipid and total sugar content. However, I do not believe that the sugar is raffinose. Isolate II does not have a measurable sugar content as determined by the Munson and Walker procedure.

NEW PRODUCTS FROM OILSEEDS

by

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(Presented by J. J. Spadaro)

More than 250,000 botanical species of plants are known to exist throughout the world. Only 250 are used for commercial purposes in the United States, and of these about 10 percent are oilseeds. The most common oilseeds in the U.S. are soybeans, cottonseed, peanuts, flaxseed, safflower, sunflower, and castor bean.

Normally, oilseeds are pressed or solvent extracted for the oil, which processes result in a crude oil fraction and a meal fraction. The two most valuable materials from either operation are the vegetable oil itself and the protein in the meal.

The vegetable oil normally has a higher value per pound than the protein meal in the seed. Oil is extensively used in human foods and in animal feeds, and it has increasing outlets as a raw material for chemical intermediates. However, all successful commercial oilseed crops must have a market value for the protein meal remaining after the oil has been removed. The overall economics of oil recovery depends on marketing the meal. Only where the oil is a byproduct (e.g., corn oil) does a different situation exist, and even under these conditions, some value must be received from the grain residues left after the oil is extracted.

The changes in relative values of oil and meal have been in favor of the meal, at least for soybeans even though oil content of soybeans has increased and more efficient methods of extraction have been developed. For example:

	Soybean		Fats and Oils Used
	Oil Value, Percent	Meal Value, Percent	Billion lb.
1947	53	47	6.1
1967	32	68	9.9

Three factors have been responsible for the change:

1. Increased world supply of oils.
2. Displacement of fats and oils by synthetics in several uses.
3. Increased demand for protein meals to feed livestock.

Of all the fats and oils produced, two-thirds are used for food and one-third for nonfood uses.

The chemist knows vegetable oils as glycerol esters of fatty acids. There are a large number of these acids, and their possible combinations in an oil are practically unlimited. Thus every vegetable oil is different chemically to a certain extent and has different properties. This difference serves as a basis for the development of new and unique chemicals and products. For example, some of the major fatty acids are stearic, oleic, linoleic, and linolenic. All consist of 18 carbon atoms. The only difference between these four fatty acids is the number of hydrogen atoms they contain. This variation may seem small, but it is the basis for the margarine and vegetable shortening industry. For example, a fat composed primarily of stearic acid is a solid at room temperature, but if the major fatty acids are composed primarily of polyunsaturated compounds such as linoleic acid, the fats are liquid at room temperatures. Extensive research is being and has been conducted on controlling unsaturation to tailor-made foods and to reduce or eliminate specific undesired properties.

Oilseed meals, on the other hand, have been the basic protein concentrates for the animal feed industry in the United States and, in fact, throughout the world. Most of these meals contain 30- to 50-percent protein.

There has been extensive research and development effort to upgrade and use oilseed meals, and products produced from them, in human foods and in industrial markets. In general, it requires only about 15 percent as much "feed material" to produce a pound of vegetable protein as to produce a pound of beef (animal) protein. Both the need for foods in the developing countries and,

*As of December 3, 1970, Northern Utilization Research and Development Division changed to Northern Marketing and Nutrition Research Division.

particularly, the need for protein foods at relatively low cost have made the development of high-protein foods from oilseeds or oilseed meals more urgent.

Among the developments are protein-rich foods prepared from the whole oilseed, its meal, isolates, and oil.

Whole seed. — 1. Full-fat soy flour. — Processes have been designed to prepare full-fat flour from which nutritious and low-cost foods can be produced, especially for use in the developing countries. A "village process" has been developed which involves only dehulling, grinding, and open-pot cooking of soybeans by native labor. The simplest of processing equipment is used.

A more advanced process has also been developed for mechanically handling and processing soybeans by extrusion-cooking. The uniform and quality-controlled finished flour is then packaged and supplied in bags. Full-fat flour is consumed as an ingredient in porridge and a beverage or used as an ingredient in baked cookies or cakes.

2. Partially defatted peanuts. — A process for the partial defatting of peanuts has been developed and commercialized. At least 50 percent of the oil (and calories) are removed by a controlled-pressing operation. The misshapened, pressed peanuts are then placed in hot water and in less than 2 minutes return to their original size and shape. The peanuts are then roasted. The oil removed by pressing is sold to the regular peanut oil markets.

3. Tamunuts was developed at Texas A&M. — Tamunuts is a nutlike food product prepared from whole glandless cottonseed kernels. They contain 35.5-percent protein and 40-percent oil. The product has been tested in spreads, candies, cookies, and other bakery items and in direct consumption snack foods. Also, when mixed with rice, they proved tasty. Protein content was increased threefold when toasted kernels were added to dry rice in a 1:1 ratio by volume.

Several preparation methods were used:

1. Toasted in rotisserie oven.

2. Toasted under vacuum and then subjected to superheated steam (15-17 in. vac. for 20, 24, 26 min.) (steam for 0, 4, 6 min.).

3. Steamed at 15 lb. press. for 10 min. — roasted at 350° F.

Selected preparation. — 4. Toasted at atmospheric pressure without steaming to end temp. of 286° F.

Tamunuts were also ground and used to prepare a cracked-wheat type bread. Protein was increased from 12.2 to 16.6 percent, when 13.3 percent of final bread wt. was tamunuts.

Oilseed meal. — 1. CSM blend. — A corn-soybean-nonfat-dry milk mix fortified with vitamins and minerals, called CSM, has been developed and supplied throughout the world. It is practically a complete food by itself, although it is intended for use as a supplement.

More than a billion pounds have been shipped to developing countries. Other oilseed flours, such as cottonseed and peanut, have also been incorporated in these mixes. The mix can be made into a drink and can also be served as a porridge.

2. Textured vegetable proteins. — Textured vegetable protein products have been developed and are extensively used in the preparation of meatlike products. The basic starting material is soy flour (50-plus-percent protein) or a protein isolate (95-plus-percent protein). Flavoring materials are added, as desired. Products that are practically identical to meat are available and the market is rapidly increasing. Simulated turkey, chicken, bacon, ham, beef, and fish products which were prepared from textured vegetable proteins are on the grocery shelf.

These nutritious products are predicted to cost, in the future, less than 50 percent of the cost of natural meat, at a comparable stage of processing.

3. Cottonseed flour. — One commercially available cottonseed flour (Proflo) has been marketed for several years and is produced by special processing of screwpressed meals. Only one new product from cottonseed meal has been produced commercially since that time. A cottonseed flour, Delpro, from prepress solvent-extracted meal was recently introduced and marketed in the Wilson, Ark., area.

Appreciable research has been underway in recent years to produce edible flours with high-protein solubility from both glanded and glandless cottonseed. The one with the best commercial potential is the Liquid Cyclone flour prepared from glanded seed. As pointed out during the panel discussion, a small plant has been built in India; and several U.S. companies have shown appreciable interest. The Liquid Cyclone flour is low in gossypol, bland in flavor, light in color, and produces highly acceptable bakery products when mixed with wheat flour.

Glandless cottonseed flour also has good potential, providing sufficient amounts of glandless seed are produced. Pilot-plant and commercial trials have shown the feasibility of producing glandless cottonseed flour.

4. Cottonseed and peanut concentrates by air classification. — Based on laboratory data for air-classification or solvent-extracted glandless and glanded cottonseed meals, test runs were conducted in the pilot plants of two commercial equipment manufacturers. Tests showed that a 70-percent protein concentrate could be produced with a yield of over 50 percent. A yield of over 60 percent was obtained with peanuts. Results were sufficiently

encouraging in that our laboratory purchased a Majac pilot-plant pulverizer-classifier unit for further experimentation. This unit was selected because pulverization or (grinding) is obtained by impact of particle against particle and was conducive to separation of whole pigment glands when glanded meal was used.

Factors in air classification that affect the preparation of a protein concentrate are the moisture content of the materials during processing, oil content of the meal, and the grinding and air classification procedures.

5. Cottonseed isolate. — Cottonseed isolate is another important potential product from cottonseed meal. This has been discussed in appreciable detail by the previous speaker. Test runs have been made in the pilot plants of two food companies.

6. Extruded cottonseed products. — Various mixtures of glandless cottonseed flour with white and brown rice and mixtures of Liquid Cyclone flour with white and brown rice were extruder-cooked to produce expanded products that can be used as snacks, as a breakfast food, and perhaps in high-protein drinks. The mixtures included 10- and 20-percent cottonseed flours, The expanded products were coarsely ground for use as a high-protein breakfast cereal and finely ground for beverage use.

7. Cottonseed butter. — Cottonseed butter was prepared by mixing glandless cottonseed flour or Liquid Cyclone flour with refined vegetable oil, monoglycerides, sugar and salt, and the mixture roasted for 35 to 40 minutes at 350 degrees.

The advantages of this method of preparation as compared to grinding roasted cottonseed kernels are that:

(1) The possible problem of cyclopropene ac is eliminated.

(2) Butter can be "tailor-made" in that different oils can be used to impart desirable flavors and to obtain products with oil content having various degrees of unsaturation.

(3) Permits the use of meals such as Liquid Cyclone meal from glanded cottonseed.

8. Peanut flours, meals, and grits. — A study was made to develop peanut products for use in preparation and fortification of processed and convenience foods.

Peanut flours, meals, and grits with different levels of oil content were prepared by solvent extraction and by screwpressing methods from peanuts with different degrees of roasting. These products were evaluated in over 100 recipes.

Tests showed that the peanut flour can be used in several products such as: Soups, spreads, puddings, ice cream, confections, bread, and many other items.

A peanut flake product prepared by mixing the flour and other ingredients with water and drum drying, appeared to have good possibilities as a breakfast cereal. Similarly, extruded peanut products in the shape of chips, ribbons, curls, and sticks have possibilities as snack items.

9. Vegetable whips and drinks. — Vegetable oilseed proteins and oils have become standard in the production of food whips and milk replacement. Lower cost products and longer shelf life have been major factors in their adoption. Whipping cream has almost disappeared from most homes and eating establishments. Some experts even predict that fresh milk and dairy products will eventually disappear in the foreseeable future.

Other oilseeds. — 1. Safflower seed is processed primarily for oil, which is used as a salad oil and in margarine, mayonnaise, and shortening. It is also an excellent drying oil for paints and varnishes. The meal is an important byproduct and is used as a protein supplement in livestock feed.

Two meals are produced:

a. Undecorticated — 23-percent protein, 35-percent fiber

b. Decorticated — 40-percent protein, 14-percent fiber

The whole seed may be ground with other grains and used as part of a livestock ration.

Varieties are being developed that have lower hull content and higher oil and protein content.

Isolates and concentrates have been prepared from safflower meal.

A patent has been granted to General Mills for the preparation of spun fibers from the meal.

2. Sunflower. — The oil "appears" to be comparable to cottonseed oil in quality and can be expected to be competitive in price. In world production, sunflower oil is the third largest — 3.1 million tons.

The meal is valuable as a source of animal feed, particularly since no nutritional toxin has been reported present in sunflower seed.

3. Rapeseed. — Rapeseed is fifth in world production of oilseeds. Food Research Institute of Ottawa, Canada, has shown that a white, bland, defatted, thioglucoside-free flour can be prepared from rapeseed. (Obtained a 44-percent yield of 60-percent protein.)

Rapeseed meal as a protein source has been limited due to its content of thioglucosides, which liberate toxic isothiocyanate and oxazolidinethione upon enzymatic hydrolysis.

Oil is used for human foods and in plastics manufacture.

4. Sesame. — Sesame seed is used with seedcoat removed.

Sesame oil is a good salad oil; one company says that sesame oil "increases shelf life of our products by 50 percent and makes cleaning of equipment easier. There is no gummy residue. Sesame oil is worth at least 2¢ a lb. over other oils."

Sesame butter-processed seeds are ground and macerated in its own oil to produce a homogenized butter. Widespread uses in the baking industry is indicated. Also, as a spread, it brings out improved bread flavor when used at low levels. Sesame has been used only on top of bread. Now, sesame can be used in the dough to produce a distinctly flavored bread with exceptional keeping qualities by using about 15-percent sesame butter. It also improves vanilla flavor and eating qualities of ice cream. It can be blended with nuts in candy. The protein content of the butter is 32 percent.

Sesame flour — predicted uses of sesame flour are as follows:

1. In bread to increase protein content,

2. as a cereal food,

3. in baby foods,

4. as a filler in meat products.

Vegetable oils. — 1. Salad oils. — Soybean salad oils having good flavor stability are now available on the market. Approximately 6.6 billion pounds of soybean oil were produced in the United States in 1969. Soybean oil used domestically is essentially equal to the total weight of all other vegetable oils combined. Research continues to provide leads to improvement of soybean oil with probable increases in market. For example, a new catalyst consisting of a specially activated compound containing copper and chromium is highly effective in the selective conversion of unstable linolenate to a more stable form during hydrogenation without hardening of the oil. Winterizing is not required.

2. Castor oil industrial products. — Methods for converting low-cost hydrogenated castor oil esters to ketostearate esters with unique chemical and physical properties have been developed. Processing costs are only a few cents per pound. These products find use in such products as permanent-type automobile lubricants and mold-release compounds.

Castor oil based rigid urethane foams have also been developed and show promise for industrial use.

3. Crambe oil industrial products. — Crambe is now under development as a new crop for the American farmer. Crambe oil, which constitutes more than 30 percent of the seed, contains approximately 60 perce. erucic acid. Erucic acid serves as a raw material for the production not only of plasticizers, but also of new polymers such as nylon 1313. Nylon 1313 is tough, has low-moisture absorption, and flows easier at lower temperatures than textile-type nylons. These characteristics are valuable for metal coatings and adhesives, and for the manufacture of bearings, electrical insulators, brush bristles, and other molded and extruded articles.

4. Linseed oil protection for concrete. — Spreading salt for ice and snow removal has caused increasing damage to concrete highways. A thin coating of linseed oil helps to protect concrete against spaulling and chipping caused by weather exposure and de-icing chemicals. The oil may be applied as a solution of oil and mineral spirits or as an oil-water emulsion. The Bureau of Public Roads has endorsed the application of linseed oil coatings. At least 40 states now use linseed oil to some degree for coating bridges and some include application to highways.

5. Cocoa butter-like fats. — In the original development, cocoa butter-like fats were prepared by interesterification and fractional crystallization of hydrogenated cottonseed oil and a triolein product in the presence of a solvent.

More recently, a process was developed for preparing the fat from cottonseed oil stearine — a byproduct from the solvent winterization of cottonseed oil. The stearine is partially hydrogenated and then the reaction product fractionated. Potential uses are in confectionery products.

6. Acetoglycerides. — Several types of acetoglycerides are manufactured primarily by substituting acetic acid for a portion of the fatty acids. They are used in foods, pharmaceuticals, and cosmetics; in coating foods such as nut meats, raisins, and dried fruits; and as lubricants in the manufacture of candies. They also have potential use as coatings in other foods but each needs to obtain approval.

7. Methyl esters. — Methyl esters are prepared from acidulated cottonseed soapstock. Methanol and soapstock are heat-treated at 115° F., 150 p.s.i.g. for 12 minutes in the presence of an acid catalyst. Methyl esters are used as a feed supplement.

8. Sucrose esters. — Potential use is as an emulsifier. In small amounts it can improve the properties of bread made with protein supplements such as cottonseed flour, soy flour, sesame seed flour, wheat germ, etc. The addition of sucrose esters tends to overcome effects on volume, crumb grain, and softness.

Potential new oilseed products. — USDA's screening and evaluation program has already resulted in several new oilseeds that have potential industrial uses. The oil content and acid constituents in these new oilseed crops are conducive to their utilization.

SUMMARY

Some of the recently developed products from oilseed and the processes for their production have been reviewed. Included in the developments outlined are protein-rich foods prepared from whole seeds and from meals, flours and isolates, and edible and industrial products prepared from the oils. The potential use of products in the future from oilseeds is practically limitless.

Primarily because of the protein content, oilseeds are now one of the most important world foods for man and animal. More and more human consumption, with omission of the animal feeding step, can be expected in the future, particularly with the greater and greater need for protein foods to supply the increasing world population.

PROGRESS IN SOY PROTEIN PRODUCTS FOR FOOD

by

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Although this conference is designated a Cottonseed Processing Clinic, basically, as we have heard earlier in this conference, each of us, in one way or another, is concerned with the production and utilization of vegetable protein and vegetable oil. In recent years, we have heard much about the existing and ever-growing need for food protein, be it from animal, fish, vegetable, or more exotic sources. As producers of vegetable protein, we must be concerned with these needs as they exist and develop both at home and abroad. Overseas, in many developing areas the need for protein in acceptable food form is immediate; at home, there is a very real concern about existing malnutrition among certain segments of our population, and, in addition, we must also be concerned about our food protein resources for the future. And certainly, we expect the resolution of our concerns to come about within the framework of our free-enterprise system.

Today, I want to review, in a brief and very selective way, some of the recent progress made in the production and utilization of soy protein products for food (figure 1). I am sure that many of you will agree that what we do with soybeans for direct human consumption will, in great measure, provide the guidelines for the food utilization of other oilseed proteins. Earlier in this Conference, several speakers discussed certain aspects of oilseed protein products for food, and hence some repetition is unavoidable. However, I think this will serve to emphasize certain important factors and trends in advancing the utilization of oilseed protein products.

Now let me turn to the current processing of soy protein products for food. Later I will address myself to the very important question of utilization.

PROCESSING OF SOY PROTEIN PRODUCTS

Soybeans. — The statistics on the annual domestic production of soybeans are well known to most of you. Again in the 1969 crop year, over a billion bushels of soybeans were produced (3). With the continuing expansion of bean production into new growing areas, we have a bountiful reservoir for the production of food protein, either through the production of livestock, poultry, and milk, or for direct human consumption.

But what about soybean production in other areas of the world? Since the early sixties there has been a significant increase in production in Mexico, Brazil, and Columbia, all areas with immediate food protein needs. Increases elsewhere have been less dramatic. Nonetheless,

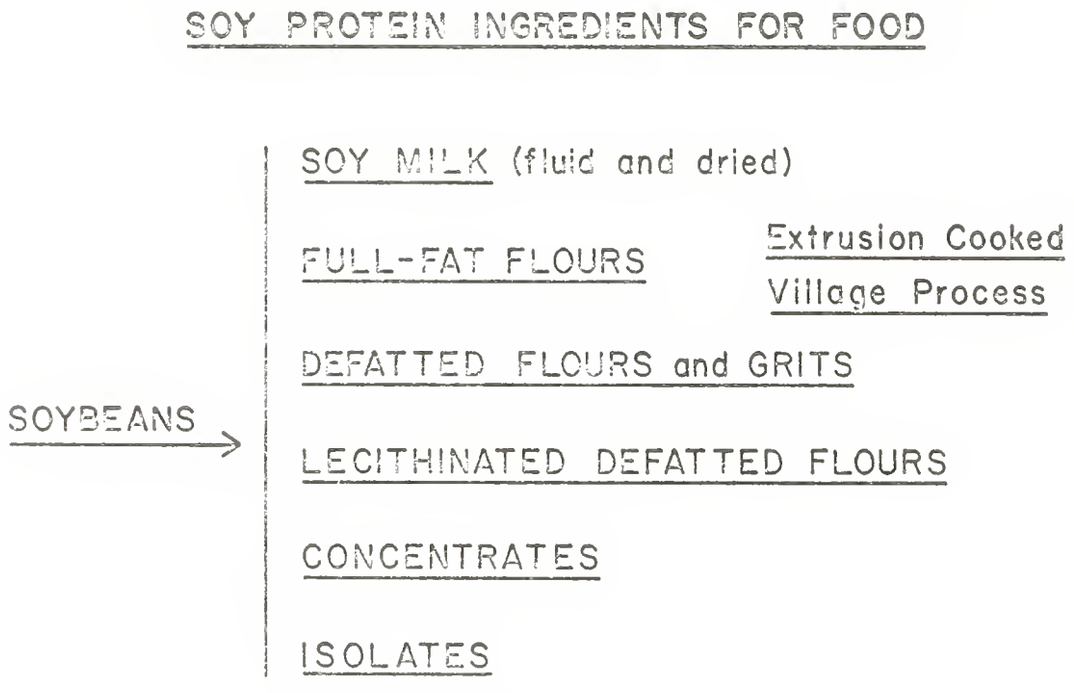

Figure 1. — Soy protein ingredients for food.

world production of soybeans for the 1968 crop year was estimated to be about one and one-half times the average production for the 1960-64 crop years (3), or about 1.5 billion bushels. Recent field trials in India sponsored by the Agency for International Development (AID) indicate that certain areas of that country are well suited to the cultivation of soybeans with prospects for excellent yields (3). Also, there are encouraging indications that soybeans can be grown as a rotation crop in the Philippines. With increasing production in other countries, particularly in the protein-short areas, the potential of the soybean in significantly contributing to world food protein supplies becomes more real.

In the United States, certain practices have been introduced, over a period of years, in utilizing soybeans for the production of food-grade protein products. Today there is a better selection of beans as to grade, but not as yet as to variety. Such selection must await a better appreciation of the relation of varietal characteristics and total food values. More attention is now given to the removal of foreign matter of field origin, and to controlled storage to prevent damage and contamination. A recently published study (12) from the Northern Regional Research Laboratory of the USDA, based upon an extensive sampling of beans moving in commercial domestic channels, indicates that the incidence of aflatoxin is very low, being limited to the highly damaged beans of sample grade.

Soy flour, grits and flakes. — There have been no recent major changes in bean preparation, solvent extraction processing, and milling for the production of defatted flours and grits, and of defatted flakes for the preparation of concentrates and isolates. However, today more attention is given to sanitary plant design, and to sanitation control to provide products with acceptable microbiological profiles for food. Also, greater emphasis is placed on the control of moist-heat processing and related treatments in order to achieve functional and nutritional properties commensurate with end-use.

Although full-fat soy flour has never become a significant factor in the United States soy flour market, this product has received renewed attention in more recent years. This attention has been prompted by the recognition that full-fat soy flour is a low-cost, protein-and-calorie-rich food ingredient which can be made in simple processing units located in areas of need. With sponsorship from the Agency for International Development (AID), the USDA has developed two processes for making the flour. One is the Extrusion Cooking Process suitable for urban communities in developing countries (10). The other is the Village Process which requires only simple equipment, hand labor, and minimal operator training (1). Demonstration trials of this process have been conducted in Brazil with equipment purchased by United Nations Children's Fund (UNICEF).

Soy protein concentrates. — The general aspects of the processing of soy protein concentrates have been described in a number of publications and patents. Three basic processes are currently employed in making the concentrates. In the main, these differ in the means employed in immobilizing the major protein components of defatted soybean flakes or flour during separation of the sugars and certain minor flake components as shown in figure 2. The products of all three processes are similar in certain compositional characteristics which define a soy protein concentrate. Yet they may vary as to color,

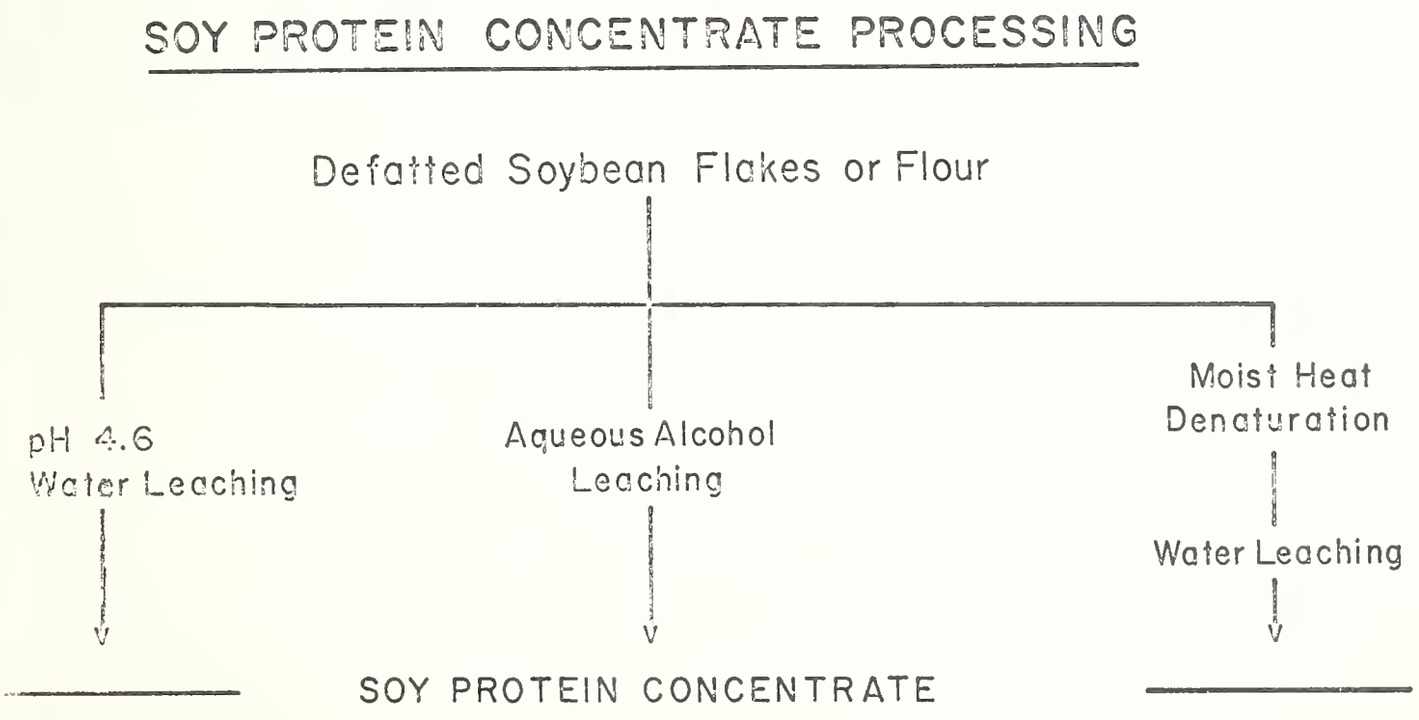

Figure 2. — Soy protein concentrate processing.

flavor, and protein solubility, and as to certain physical characteristics such as particle size and absorption which are of importance in food manufacture.

Soy protein isolates. — Although the basic principles of protein isolation from the soybean were established many years ago with foundations which reach back into oriental antiquity, the food-grade isolates have been commercially available in quantity for only about 10 years. In these years and somewhat earlier, the principles of commercial processing have been described in published literature with definition of the major variables and unit operations (figure 3). Few specific details on plant design and operation are available since large-scale know-how is presently restricted to a few industrial organizations. Nonetheless, we will witness a continuing expansion in the production of the isolates. An isolate of Japanese manufacture has recently appeared in world markets, there is news of the completion of an isolate plant in Brazil, and I am certain that there is new domestic interest in isolate production. In spite of the fact that the isolates, as currently defined, are and will be the most expensive of the soy products per unit of food protein, they possess a degree of flexibility and potential in food manufacture not presently shared by the other standard soy protein products. It is obvious to consider that the changing patterns of utilization of the several soy protein products will be dictated not by cost alone, but also by suitability for end use in relation to market demands and needs.

Composition of soy protein products. — Several tables are presented here simply to refresh your memories as to certain basic compositional differences between the soy flours and grits, concentrates and isolates. Table 1 gives a comparison of the soy protein products as to varying protein, fat, and crude fiber contents. Table 2 gives the essential amino acid composition of the soy protein

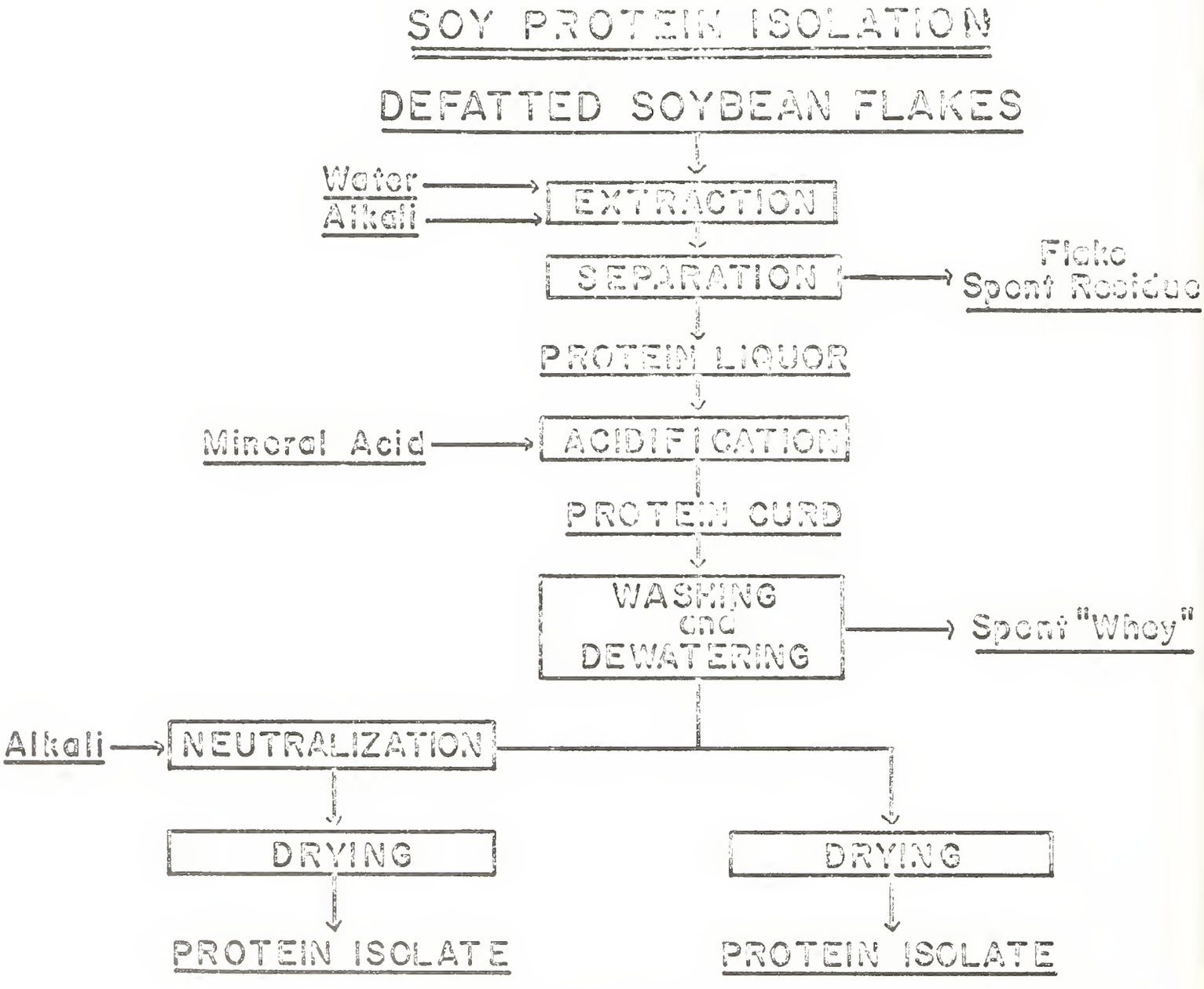

Figure 3. — Soy protein isolation.

Table 1. — Proximate analysis of commercial soy protein products

Product	Moisture	Protein[1] (N x 6.25)	Fat	Crude fiber	Ash
	Pct.	Pct.	Pct.	Pct.	Pct.
Soy flour and grits (full fat)	5.0	46.6	22.1	2.1	5.2
Soy flour and grits[2] (defatted)	7.0	59.0	0.9	2.6	6.4
Soy flour (lecithinated)	5.5	48.6	16.4	2.2	5.3
Soy protein concentrate	7.5	72.0	—	3.5	5.5
Isolated soy protein	5.0	98.0	—	0.2	4.0

[1] Moisture-free basis.
[2] Defatted soy flour and grits are available in a variety of heat treatments.

Table 2. — Amino acid composition of soy protein products (average values)

Item	Essential amino acids, g./16 g.N[1]		
	Defatted soy flour	Soy protein concentrate	Isolated soy protein
Lysine	6.2	6.2	6.0
Methionine	1.3	1.3	1.1
Cystine[2]	1.2	1.6	1.0
Tryptophan[3]	1.4	1.4	1.3
Threonine	4.2	4.3	3.7
Isoleucine	4.6	4.9	4.8
Leucine	7.7	8.0	7.8
Phenylalanine	5.3	5.3	5.5
Valine	4.9	5.0	4.8

[1] Ion-exchange chromatography.

[2] Determined as cysteic acid — Schram et al.

[3] Colorimetric method — Spies and Chambers.

products. Herein the critical differences of nutritional consequence are in the sulfur amino acids. All soy protein products afford an adequate complement of the other essential amino acids. For food, however, the nutritional value of the soy protein products per se is only part of the picture. Their value must be assessed in relation to the nutritional value of the finished food item as eaten. This point should be stressed since processed foods are often composed of several protein-containing products, which may complement one another and are often heat processed which can either increase or decrease nutritional value.

UTILIZATION OF SOY PROTEIN PRODUCTS BY FOOD

Now let us consider the utilization of soy protein products for food. A major and continuing challenge in fostering further utilization lies in economically converting these products into appealing and nutritious foods, either through incorporation in conventional foods or through the fabrication of new protein foods having broad consumer appeal. In the past 10 years much progress has been made, but we must learn more about the use of vegetable proteins in making foods which generate and maintain consumer acceptability in both developed and developing countries. Feedback from this area of endeavor is stimulating improvement and change in the food quality and in the food-forming characteristics of the basic soy protein products.

Soy flours and grits. — Of the commercially available food-grade soy protein products, the flours and grits are produced in the largest volume. Various estimates of volume, ranging up to 250 million pounds per year for food, have been made, but it is difficult to assess the reliability of these estimates.

The current domestic uses of soy flours and grits are given below. Bakery goods and processed meat products are the main outlets.

Food uses of soy flours and grits:

Bakery products	Processed meat products
Bread and buns	Sausages
Doughnuts	Luncheon loaves
Sweet goods	Patties
Cakes and cake mixes	Chili
Waffle and pancake mixes	
Specialty crackers	Textured meat-like analogues (extruded)
	Breakfast cereals
Infant formulations and junior foods	Confectionery items
	Dietary foods

With the changing price structure of nonfat dry milk for manufacturing purposes, there has been an increasing substitution of soy flours and soy flour-whey solids blends for nonfat dry milk in bread and other bakery goods. In recent years, a flour specifically designed for use in bread, buns, cakes, and cake mixes has been introduced (13, 14). Although functional properties such as enhanced absorption, moisture retention, and improved machining qualities and ingredient cost savings are prime reasons for domestic use, a number of investigations have demonstrated that soy flour provides good nutritional value in bread (6, 7). Several recent publications indicate that the eating qualities of leavened bread containing rather high levels of soy flour can be improved by the addition of low levels of selected glycolipids (11). The excellent protein supplementation value of soy flour in cereal grain foods is the basis for several commercial ventures and pilot programs providing enriched foods in protein-short countries (2).

In other domestic uses such as hypoallergenic infant formulations, junior foods, and breakfast cereals, the nutritional contribution of soy flour is of prime importance.

Textured vegetable protein foods from both flours and isolates were discussed earlier in this Conference. At this point, it will suffice to say that this is an excellent example of one approach in facing the challenge of designing new foods in the semblance of traditional food forms which have broad consumer appeal.

Soy protein concentrates. — The following list of current food uses of the concentrates are not as diverse as those of soy flour and grits.

Food uses of soy protein concentrates:

Comminuted meat products	Bakery products
Sausage	Cake mixes
Luncheon loaves	Bread
Patties	Breakfast cereal
Chili con carne	Dietary wafers
	Milk replacer for young animals

It is estimated that the concentrates are now being produced at a volume somewhat over 20 million pounds per year. The concentrates have, in general, better flavor characteristics than the flour and grits, and provide important functional properties such as moisture absorption, juice holding and fat binding properties. These qualities together with excellent nutritional properties at reasonable cost make the concentrates valuable additives in comminuted meat items such as meat patties, meal loaves, luncheon loaves, and sausage. For the future, I feel there will be an increasing trend toward extending our animal protein foods with concentrates and other vegetable protein products as the former become more costly to produce. The extension of animal protein products with vegetable proteins, such as in the toning of milks or in producing nonfat dry milk-containing food powders is of immediate interest in protein deprived areas.

Soy protein isolates. — Since their commercial introduction in about 1959, the food-grade isolates have grown in production volume to an estimated 18 million pounds per year. Much of this growth has been due to the functional properties of the isolates which are of value in food design and processing. These include properties such as solubility and dispersibility, emulsifying, emulsion stabilizing, fat and water binding, gelling, fiber forming, and the like. The listing of current major uses underscores this fact.

Food uses of soy protein isolates:

Processed meat products
- Sausages
- Luncheon loaves
- Canned luncheon meats
- Poultry rolls and products
- Dehydrated meat bits

Beverages

Dietary foods
- Textured meatlike analogs (spun fiber)
- Infant formulations
- Dairy-type foods
  - Whip toppings
  - Coffee whiteners
  - Beverage powders
  - Frozen dessert

It is logical to consider that in time, new generation isolates which have improved specific functional properties designed for specific current and new volume uses will be introduced.

However, in spite of the need for functionally active protein ingredients, the nutritional value of these ingredients cannot be ignored in food design, and becomes of paramount importance in those foods which either contribute, or are designed to contribute, in a significant way to the daily intake of dietary protein. In the last several years, three improved hypoallergenic infant formulations have appeared in the market place. These are all based upon soy protein isolate as the protein source. In order to achieve good nutritional response, since the products are often the sole source of dietary protein, the protein is supplemented with an appropriate amount of methionine. A number of publications have described the supplementary value of the isolates in bread and meat products, both important sources of dietary protein (9). Another publication attests to the good nutritional value of a composite meatlike food wherein spun soy protein fiber affords the texture (5).

Lately, there has been considerable activity and interest in protein beverages, both liquid and powder for reconstitution (2). At home, there has been much concern about the so-called imitation milks. To date, their volume in the market has not been significant, and certain basic qualities must be improved before they can take on significance, namely in nutritional value and flavor appeal. Since fluid milk is an important source of our dietary protein, it is the consensus that any replacement beverage must provide comparable or adequate nutritional value. On the other hand, supplementary protein beverages should be evaluated within a different framework.

Overseas, in protein-short areas there have been several market introductions of bottled soy protein-based beverages (2). In Brazil, the Coca Cola Company is marketing flavored soy milk beverages called SACI. This follows on the success of VITASOY in Hong Kong. In Guyana, Monsanto is merchandising a nonfat protein beverage, PUMA. It has been recognized that soft drink beverages are classless and should provide an excellent and appealing vehicle for the introduction of additional food protein. In response to the level of development activity now in progress, I am sure we will see new protein beverages in both domestic and overseas markets. Snack foods and confectionery items have also been mentioned as classless food items which may afford other popular vehicles for the introduction of additional food protein.

PRICING OF SOY PROTEIN PRODUCTS

In spite of rising costs due to the inflation of our economy, there have been no recent changes in the pricing of the basic soy protein products; conventional defatted soy flours and grits sell for about 7 to 8¢/lb., the concentrates for about 18 to 20¢/lb. and the isolates 35 to 40¢/lb. I foresee no major downward change in these price structures in the near future.

FOOD LAWS AND REGULATIONS

In concluding this brief and selective review, I think it is appropriate to comment on the impact of existing food laws and regulations, including labeling on the introduction of new protein ingredients for food and of new protein foods, particularly those simulating traditional

food items. I am sure that we all agree that there is a need for soundly conceived, consistent, and equitably enforced food regulations to protect consumer health and interests. However, current food standards and labeling requirements have been a deterrent to the fuller utilization of soy protein products in certain conventional processed foods and to the marketing of the newer simulated meat foods, even though these foods may provide good nutritional value at low cost or improved nutritional value. It is encouraging to note that the Committee on New Foods (Panel III-2) made recommendations to the recent White House Conference on Food, Nutrition and Health on changes in our food regulations which, if implemented, would stimulate the introduction of new protein food ingredients and protein-enriched foods both at home and abroad (4). We must recognize that in providing food for the less fortunate overseas, we cannot expect them to readily accept foods or food ingredients which cannot be marketed in the United States.

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GOOD MANUFACTURING PRACTICES IN OILSEED MILLS

by

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It is a real pleasure to have the opportunity of speaking to the Cottonseed Processing Clinic here in the Crescent City.

The Good Manufacturing Practices (GMP) for the food industry deal strictly with sanitation. FDA's (Food and Drug Administration) concern with sanitation is rooted in section 402(a)(3) of the Act which defines an adulterated food as one demonstrably filthy or decomposed and section 402(a)(4) which further defines a food as adulterated if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth or rendered injurious to health. The law itself, however, does not contain any further specification of insanitary conditions. There was a court decision back in the early forties in which an appellate court stated that no specification of insanitation is required in this section. After all, anyone knows what insanitary conditions are. With this decision and a record of success in court cases dealing with insanitary conditions there was little pressure to attempt to clarify the requirements of the statute. This is probably, at least in part, due to the fact that at that time nearly 30 years ago it was not uncommon to encounter food manufacturing plants operating under such filthy conditions that a carefully drawn definition of sanitation did not need to be applied. There are probably here today people who can remember when some factory operating practices and the sanitary habits of some employees in food processing establishments bred conditions that would literally "gag a maggot."

Over the years, however, the efforts of enlightened management, and, we suspect, the judicious application of pressure by regulatory agencies has wrought widespread changes. Today there is considerable merit to the plea of industry that they need a more precise definition of insanitary conditions. We recognize the need for a common set of ground rules against which both industry and regulatory agency can measure performance. This, then is the GMP. The Umbrella GMP Regulations were published in April 1969. The umbrella concept developed when we started attempting to write GMP regulations for specific industries. We soon found that there would be repeated in each regulation such standard operating procedures as, "wash the equipment, provide screens on the windows, close the door, and put out the cat" every time we wrote one. For this reason we decided to try to write an umbrella that would include all of the general concepts of basic sanitary plant operations with the idea that we would subsequently prepare individual appendices spelling out specific procedures applicable to special hazards and special products.

As now constituted, the Umbrella GMP's cover six broad areas of concern to the sanitary operation of food manufacturing, processing, packing, or holding facilities. These are in order: plant and grounds, equipment and utensils, sanitary facilities and controls, sanitary operations, processes and controls, and personnel. Since I am sure that you are all reasonably familiar with the details of these regulations a recitation of their content would serve no useful purpose. I spoke a moment ago about appendices to these regulations for specific industries. For obvious reasons our priority list for the development of these appendices is related to the degree of susceptibility of products to becoming vectors of human illness. For example, appendices on such items as hot smoked fish, breaded shrimp, soft filled baked goods, nonfat dry milk, egg products, etc., are high on the priority list and much work has been done in some areas. We have published a GMP appendix on breaded shrimp which was developed through direct cooperative working relationships with the industry.

This brings me to another point. We do not profess to have in FDA the expertise necessary to write detailed GMP standards for individual specific food products. We are not staffed with large numbers of expert food technologists or with individuals versed in the economic intricacies of the competitive marketplace. In the areas where we have undertaken the development of GMP appendices we have sought the aid and advice of the industry involved. Also, there have been instances where some industries, including the pecan shellers and some segments of the confectionery industry, have come to us with an initial proposal which they have developed for our consideration.

We strongly encourage this sort of industry interest in the development of sanitation standards and we stand ready to participate to the extent that our staffing will permit in the effort of any industry to begin to develop a GMP appendix. On the other hand, because of our staffing limitation we must reserve the right to establish priorities and to make the final determination as to which appendices we will devote our time and effort.

Your own industry association has taken this route. At the present time we are using the Umbrella Regulations as our guidelines for inspection and evaluation. However, a proposal for an appendix for the crude cottonseed oil industry is being prepared. This was initiated when both Fred H. Husbands and Garlon Harper of the National Cottonseed Products Association wrote to FDA and asked for an exclusion for the industry from the GMP's on the grounds that crude cottonseed oil is a raw agricultural

commodity and by regulation thus entitled to exclusion. We replied that we could not accept this premise but that, on the other hand, we did not disagree with the view that the regulations as issued contained some requirements which should not necessarily apply to mill producing crude oil. J. Kenneth Kirk, then Associate Commissioner for Compliance, asked for either or both of two suggestions. The first would be a listing of the items in the regulations which the industry concluded are not applicable and the reason therefor. The second would be a set of proposed items which the Association believes should be considered only for this industry. These suggestions are presently being reviewed by the Association. In the meantime FDA has undertaken to develop its own proposal in the form of an appendix for the industry. This proposal very simply expands upon each of the six principal topics in the Umbrella Regulations to adapt them to conditions inherent in the industry which are essentially unique to the industry and do not necessarily constitute unsanitary practices.

While the proposal would require some changes in industry-wide practices, some retraining in personnel, and some reconstruction of facilities, we believe that the costs of these changes would be minimal; and the benefits to the industry substantial. We propose to submit this proposal to your industry for comments and suggestions.

How then does all of this relate to FDA inspections? When the FDA inspector comes into your plant he will, of course, look at a number of things in addition to sanitation. I would like, however, to restrict my remarks at this time to those aspects of the inspection concerned with sanitation or matters relating to sanitation.

In the absence of an appendix, which is the case in your industry at the moment the inspector will check for general basic sanitation. In other words, he will make his usual inspection. We do not anticipate that inspections will be any different by reason of the promulgation of the GMP Umbrella than they were before. There are certain practices and conditions which we have always regarded as objectionable; these we still regard as objectionable and the GMP Umbrella has not really added any new ones to the list. FDA has never been concerned about purely technical or otherwise meaningless compliance requirements involving properly dotted i's and crossed t's. Congress specifically empowered the Administrator to exercise judgment and to discount minor infractions for regulatory purposes. It is thus obviously reasonable to anticipate that GMP compliance will be administered in terms of things that have significance or potential significance rather than in terms of what is commonly known as "nit-picking."

You are probably asking what will be the effect of failure to comply with these regulations. I shall answer that question in this way. We in FDA regard the GMP Regulations as having the force and effect of law. Substantive failure to comply with a significant provision of the regulations will constitute a violation of section 402(a)(4) of the Act. A food product produced under these conditions will be regarded as adulterated. It is our intention to proceed against such food products and against the parties responsible for their production according to our established regulatory procedures. This means that the merchandise will be subject to seizure, the firm and/or responsible members thereof will be subject to prosecution or the firm may be enjoined from further violations of the law. This is not to say, however, that our position on this question has been received by industry and industry lawyers with universal acclaim and agreement. It is widely argued that the regulations are in fact advisory only and without the force and effect of law. In the usual course of events the ultimate answer to this question will issue from the courts.

If the foregoing sounds as if the GMP's are merely another shillelagh with which the government is going to belabor industry, let me hasten to dispel this notion. It is not true that it is the function of a regulatory agency to castigate, vilify, and generally make life miserable for the business they are charged with regulating. The food and drug industries and FDA have a common objective — to provide the consumer with sound wholesome products prepared in sanitary surroundings. There isn't much argument about our objectives although we occasionally disagree on how they shall be attained. Over the years it has been a not uncommon complaint on the part of plant management that they have not known what was expected of them by FDA until they saw us in court. It is our sincere hope that the GMP's, both the Umbrella and the appendices as they develop, will be the basis of a common understanding of what is required.

Much has been said about FDA's program of voluntary compliance in the last few years. The issuance of the GMP's is a part of that program. We believe that we have progressed beyond the stage where our major effort to effect compliance with the FD&C Act should consist of "cop on the beat" regulatory type action. When you consider the size of our field force and the size of the industries for which we are responsible, it's pretty obvious that we are not likely to get the job done with police type actions alone. With the publication of these clarifying regulations I think it is reasonable to expect that industry will be in a much better position to get and keep its own house in order.

I should like to make a point that I am afraid is sometimes overlooked by some people, at all levels of responsibility, who are engaged in the production and handling of food. The responsibilities of everyone in the food industry are quite different from the responsibilities of those engaged in say the manufacture of fountain pens or shoe polish. The health and well-being of the customer is in little jeopardy if the ballpoint pen fails to write on butter or if the shoe polish fails to shine. But, when a

family eats a commercially prepared food and is thereby exposed to salmonellosis, or botulism, or aflatoxin, or excessive pesticides, or filth in any form, it is an entirely different matter. It seems that this concept occasionally gets lost in the competitive scramble and the inherent rights of the consumer go down the tube instead of the materials that are sometimes offered for sale under the guise of wholesome food.

Returning the FDA's voluntary compliance program, let me commend to your attention another of our efforts in this direction. I am speaking of the workshop. We have presented programs of this type to a wide spectrum of the food and drug industries in all parts of the country. The presentations are generally co-sponsored by FDA and industry. The speakers are drawn from government, industry, and the academic community. According to need the material presented is gaged for top management, supervisory personnel, or the line worker.

Our experience indicates to us that this is a highly successful means of communication between industry and the regulatory agencies. As the effect of the GMP's upon your business becomes more evident, you may wish to consider a workshop or series of workshops to answer the questions which will arise and to convey the information your employees need to do the job right. On an individual basis please remember that each FDA district office is available for advice and comment on your problems. The exchange is generally more pleasant and less expensive if you call us than if we call you.

RECENT DEVELOPMENTS IN TREATING COTTON BATTING FOR FLAME RETARDANCE

by

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The Southern Regional Research Laboratory has been involved for almost two years in a research project, the objective of which is the development of flame-retardant conventional cotton batting products.

This research is a joint undertaking of the Textile Fibers and Byproducts Association, The National Cotton Batting Institute, The National Cottonseed Products Association, the Foundation for Cotton Research and Education, and the U.S. Department of Agriculture (USDA). The research is also receiving indirect support from the National Association of Bedding Manufacturers.

The urgent need for the development of flame-retardant cotton batting products arises from the passage by the Congress in late 1967 of Amendments to the Flammable Textiles Act of 1953, and the Highway Safety Act of 1967.

More than 90 percent of the cotton batting products that are manufactured in the United States each year end up in such items as automobile seats, furniture, and mattresses, all of which are covered specifically by the new laws.

The amended Flammable Textiles Act will be administered by the U.S. Department of Commerce while the U.S. Department of Transportation will administer the Highway Safety Act. The Department of Commerce has not yet arrived at standards for home furnishings, mattresses, or furniture, nor have test methods been established to define performance. The National Bureau of Standards of the Department of Commerce is taking a hard look at the flammability hazards that exist in upholstered furniture and mattresses. It would be surprising if some restrictions on the sale of these products was not forthcoming soon.

The Department of Transportation has already taken some action in connection with the flammability of automobile interiors and has announced a test procedure in December 1969.

When this research was undertaken, few guidelines existed for determining an acceptable level of flame retardance in furniture, mattresses, and automobile seating. During the course of this work it has been necessary, therefore, to develop concepts of acceptability and means of measuring performance on an objective basis.

The vertical flame test was chosen as a yardstick because it is the most difficult to pass. This selection of a test procedure was based upon the philosophy that research products should be the best possible with current technology. The test procedure involved hanging a cotton batting sample, 2 inches wide by 10 inches long, over a 1 1/2-inch-high bunsen burner flame as shown in figure 1. The flame burned for 12 seconds. The time in seconds that the sample continued to burn after the bunsen burner flame was extinguished was measured. The time in seconds that the sample continued to glow was also measured. Figure 2 shows the condition of two samples just after the 12-second time of exposure to the bunsen burner flame. Note from figure 3 that the untreated sample on the left has been almost completely consumed. The sample on the right was treated with a flame retardant that was not particularly effective. The main blackened or charred length of the sample is measured in centimeters, as is the overall scorch or light char.

The research team considers the following as the minimum acceptable levels of performance:

	Minimum level of flame retardance
Afterflame time	5 seconds
Afterglow time	5 seconds
Main char length	10 cm. (4 in.)
Overall char length	15 cm. (6 in.)

Because cotton batting is utilized under a wide variety of environmental conditions, it is important that measures of performance be obtained after samples have been exposed under different environmental conditions. Samples are tested after (1) conditioning at 70° F. and 65 percent relative humidity for 24 hours, (2) 100° F. and 100 percent relative humidity for 72 hours, (3) 158° F. for 16 hours, and (4) after soaking with water and drying at 158° F for 16 hours.

Using the above test procedures and the conditioning of samples listed, it is possible to differentiate between the effectiveness of a number of treatments to the point where samples, having different degrees of flame retardance, can be selected and ranked with each other.

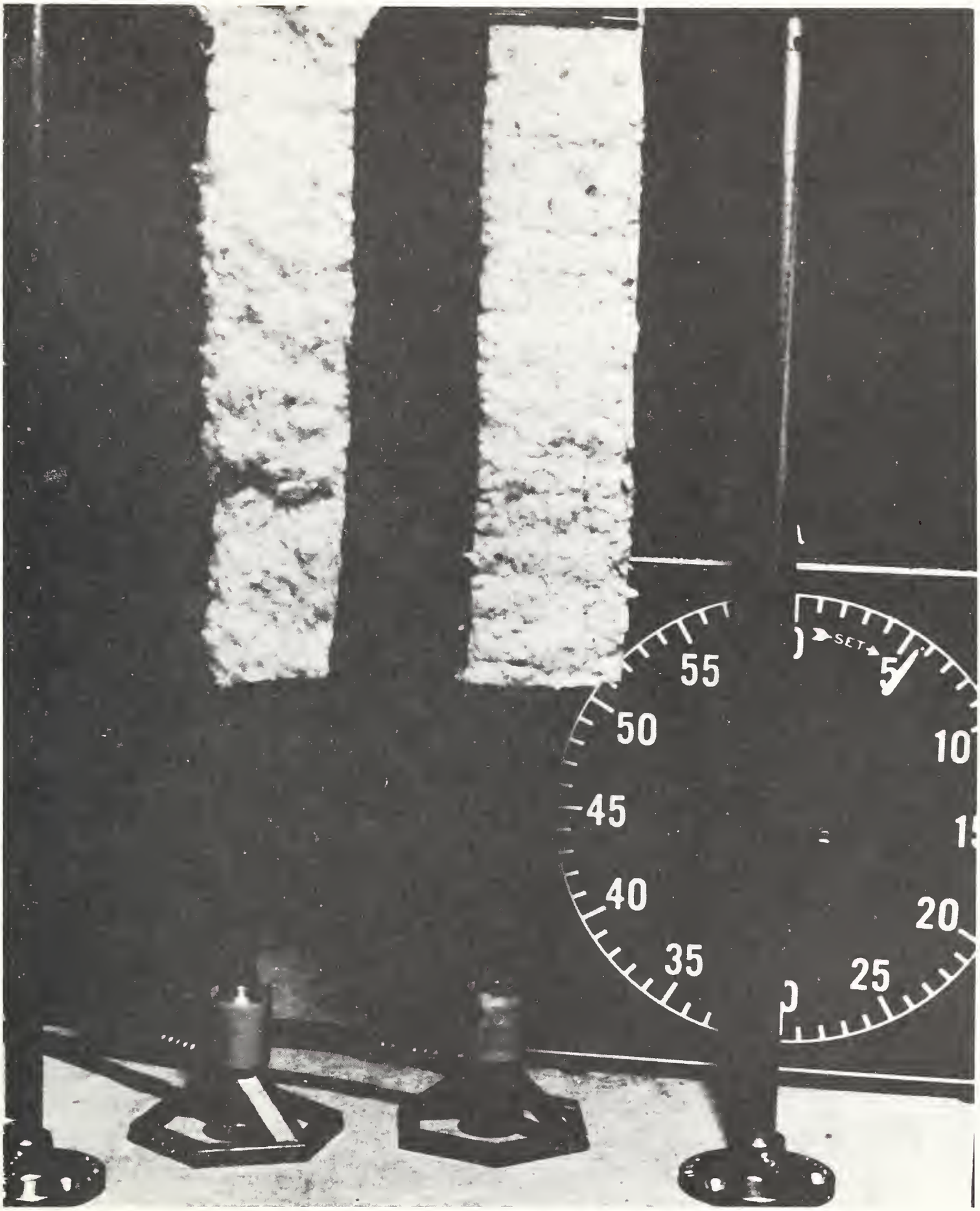

Figure 1. — Vertical flame test.

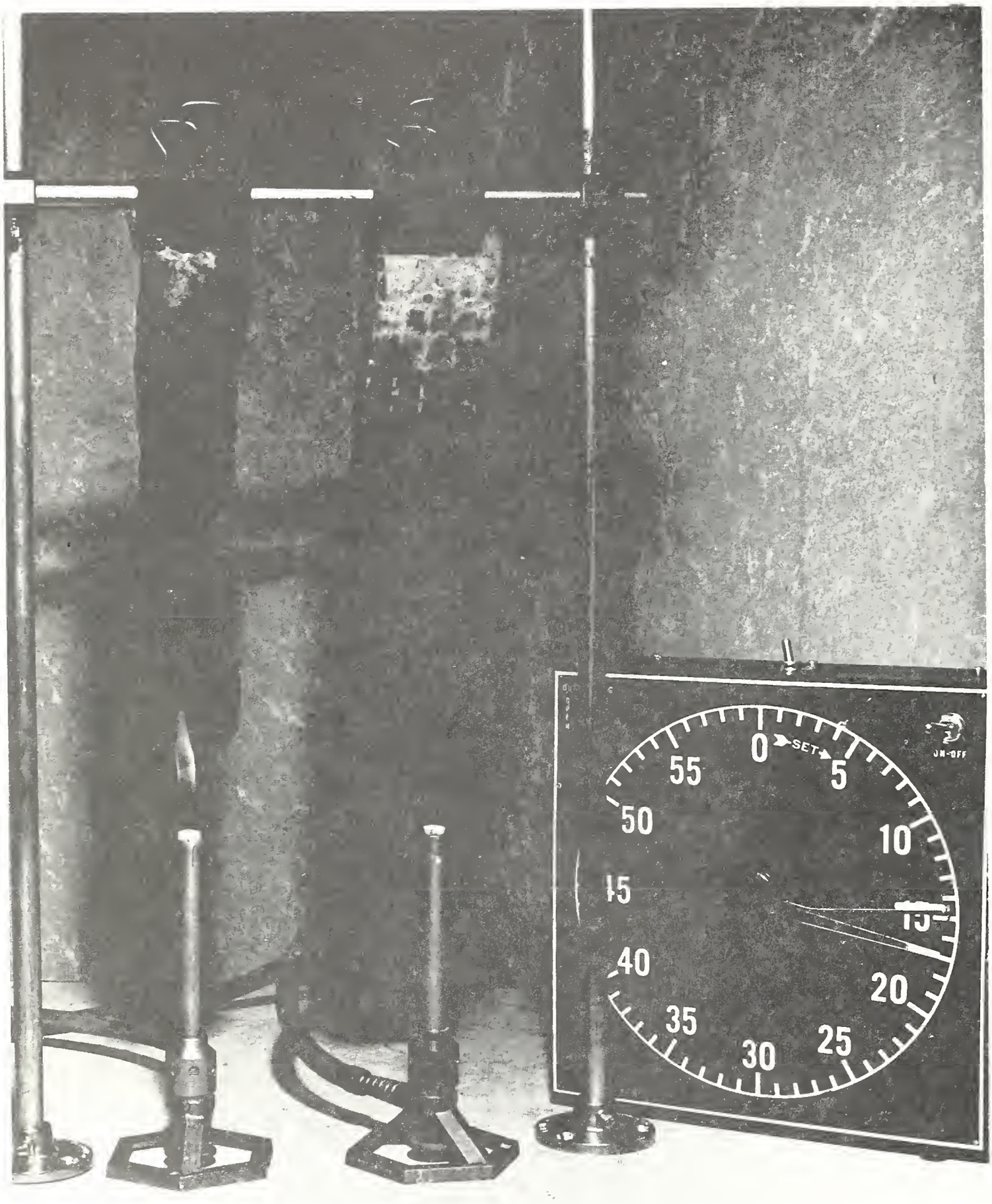

Figure 2. — Samples after 12 seconds of exposure to flame.

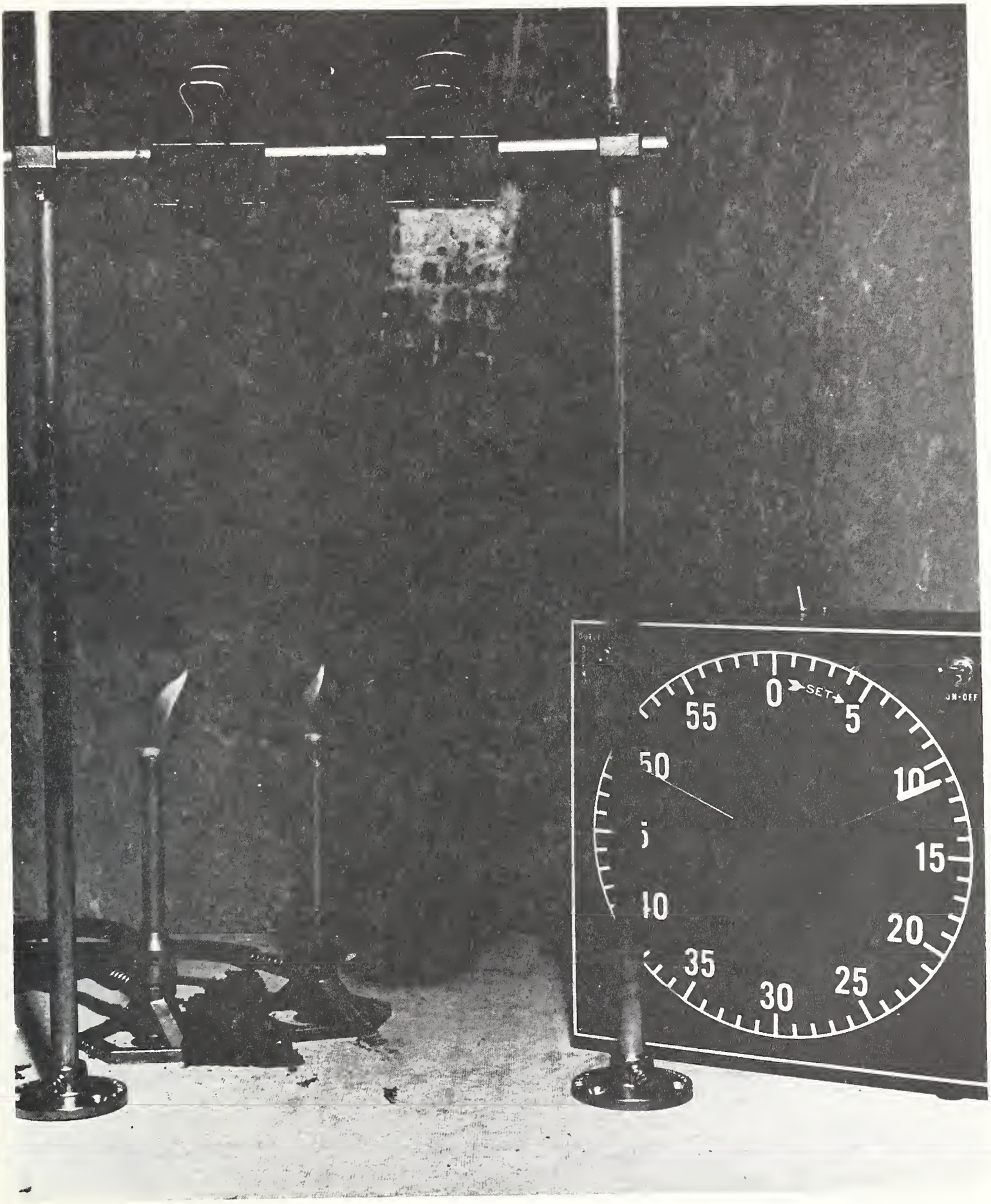

Figure 3. — Comparison of treated and untreated samples.

The criteria used in the search for flame retardant cotton batting treatments is given below:

Essential criteria for flame retardance treatments
for
cotton batting rawstock

The treatment must be:

1. Inexpensive
2. Easy to apply
3. Effective on native linters and textile wastes
4. Effective at low levels of chemical add-on
5. Durable to mild leaching, high humidity and temperature
6. Odor free after drying and curing
7. Effective in reducing afterglow
8. Physiologically inactive

While these criteria are extensive, they are a far cry from being comprehensive. For example, nothing has been said concerning the toxicity of the byproducts of the combustion of the treated fibers. This certainly is an important consideration which will undoubtedly have to be faced at a later date.

In addition to the "musts" listed above, there is also a list of "must nots" that the treatment has to meet. These are given below.

Essential criteria for flame retardance treatments
for
cotton batting rawstock

The treatment must not:

1. Be deliquescent
2. Reduce quality of webs produced
3. Significantly increase fly during garnetting
4. Affect the moisture absorption — desorption of fibers
5. Affect the air permeability of the array
6. Dust or powder off the fibers

To comply with the criteria for treatments, the research to develop flame-retardant cotton batting products has been concentrated on chemicals that cost not more than 30 cents per pound. Other economic considerations make it apparent that even at this price for the chemicals, it is necessary for the treatment to be effective at add-ons of not over 12 percent by weight of the cotton treated.

A number of techniques for the application of the chemicals to the rawstock fibers have been evaluated to determine which might be the most effective at the lowest cost. Spraying of the webs after garnetting, or the treatment of the finished batting have been more or less eliminated from consideration, at least for the present, because of problems in uniformity in the distribution of the chemical throughout the batt, or the disruption of the batting structure caused by wetting.

At this time it appears that the easiest and cheapest way to apply flame retardant is with a modified dual conveyor system in which the rawstock to be treated is fed between conveyors and immersion treated. Figure 4 shows a 16-inch-wide laboratory treating range which utilizes this technique. The conveyors pass into a treating solution, up through squeeze rolls, back down into the treating solution and then up through another set of squeeze rolls. Chemical add-on can be controlled by: (1) Varying the concentration of the treating bath, or (2) the squeeze roll pressure to vary the wet-pickup of the treating formulation by the fibers. This method of processing only requires the equivalent of picker opening provided that the fibers are fairly uniformly distributed on the belts. Early in the pilot plant research lots of 150 and 250 pounds of fibers were processed on the padder shown in figure 4 at a rate of up to 30 pounds per hour. With some minor mechanical changes this rate has been increased to 75 pounds per hour for some recent samples.

A number of chemical systems were evaluated for their efficiency in conferring flame retardance to cotton batting. The inorganic borates, inorganic ammonium phosphates, urea phosphates, phosphorous containing derivatives of dicyandiamide, and the borated amido polyphosphates all were capable of conferring flame retardance to cotton fibers at or below the preselected maximum allowable 12-percent add-on. All the above met the price per pound of chemical criteria.

Several of the flame retardants listed above had to be eliminated for consideration for one or more reasons. The inorganic borates and the inorganic ammonium phosphates tended to be lost from the treated cotton under the high relative humidity test and under the test where the samples were soaked with water. In addition, the effectiveness of the flame retardance treatments with these salts was degraded by exposure to high temperature. With some exception, most of the borates used tended to contribute to an excessive amount of afterflow in almost all of the samples in which they were used.

Some typical flame retardance performance characteristics for several different treating chemicals are given below.

Flame retardance characteristics

Sample No.	D	E	F	G
Treatment	BAP	DCY-P	PAP	UP
70° F. — 65 pct. R.H.				
Afterflame (sec.)	0	0	0	0
Afterglow (sec.)	0	0	0	0
Overall char (cm.)	2	6	4	7
Main char (cm.)	2	2	2	2

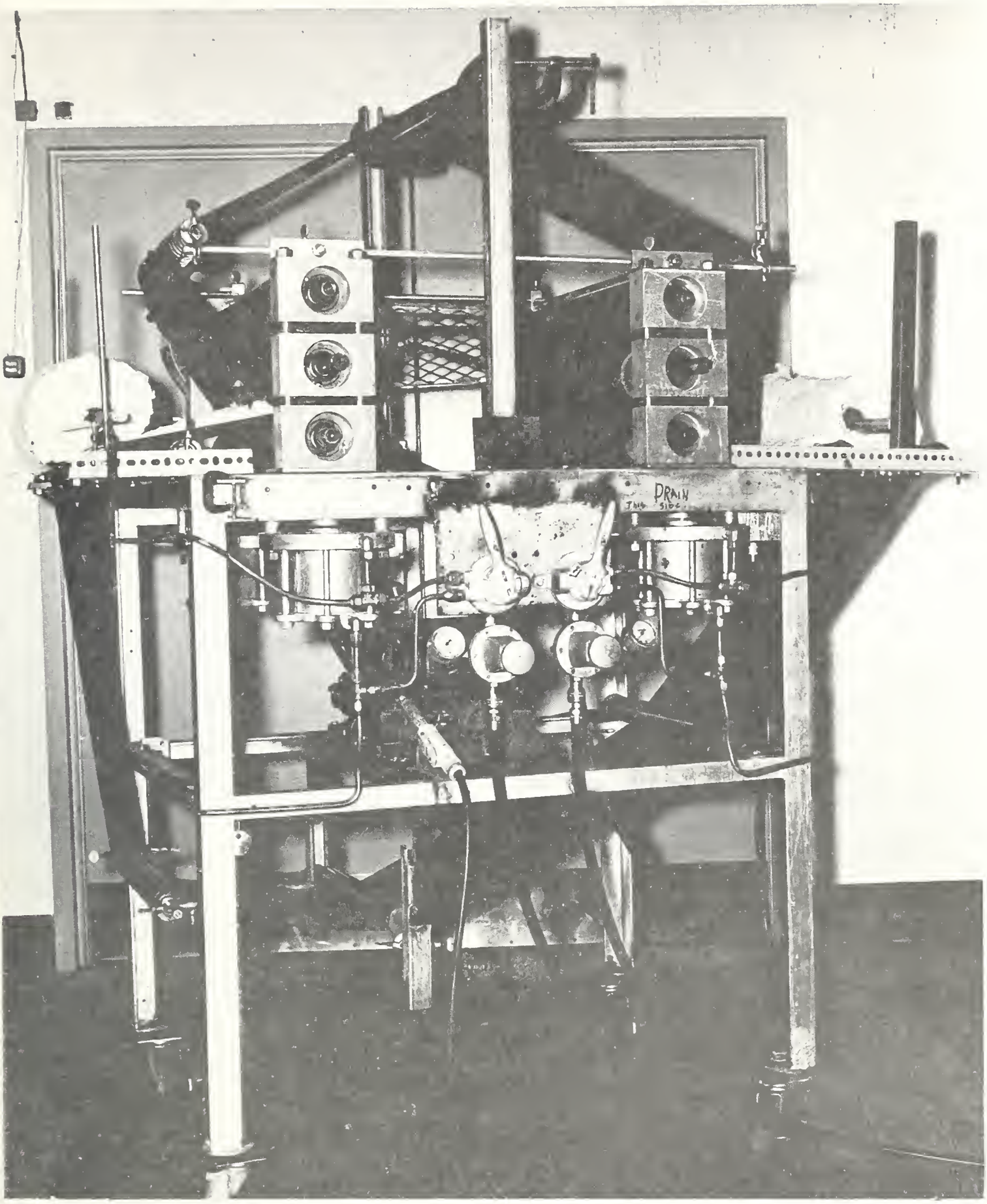

Figure 4. — Laboratory treating range.

Flame retardance characteristics (Cont.)

Sample No.	D	E	F	G
Treatment	BAP	DCY-P	PAP	UP
100° F. — 100 pct. R.H. (3 days)				
Afterflame (sec.)	0	0	0	0
Afterglow (sec.)	1	0	0	0
Overall char (cm.)	2	6	3	8
Main char (cm.)	2	2	2	2

The performance at 70° F. and 65-percent relative humidity as well as at 100° F. and 100-percent relative humidity (R.H.) is shown. The BAP refers to a borated amido polyphosphate, the DCY-P identified a dicyandiamide phosphoric acid derivative, the PAP is used to identify a propyl ammonium phosphate, and the UP to identify a urea phosphate derivative.

The borated amido polyphosphates are effective in conferring flame retardance to cotton batting. For these compounds chemical add-ons of about 10 percent are needed and the chemicals sell for about 16 cents per pound.

The methylolated derivatives of phosphoric acid and dicyandiamide were also found to be effective. These chemicals sell for about 27 cents per pound, and chemical add-ons of about 8 to 10 percent by weight of the cotton are needed.

The propyl ammonium phosphate sells for 30 cents per pound and confers acceptable levels of flame retardance when applied to the cotton fibers at add-ons of 10 to 12 percent by weight of the cotton.

The urea phosphate complexes were effective in conferring flame retardance under all of the test conditions. These compounds sell for about 30 cents per pound, and chemical add-ons of between 5 and 8 percent by weight of the cotton fibers are needed to achieve flame retardance.

The results obtained for this series of samples when they were tested after exposure to 158° F. for 22 hours and after wetting with water and then drying at 158° F. are outlined below. Note that there is little change in the performance levels of the samples under any of the test conditions.

Flame retardance characteristics

Sample No.	D	E	F	G
Treatment	BAP	DCY-P	PAP	UP
158° F. — 16 hr. (dry)				
Afterflame (sec.)	0	0	0	0
Afterglow (sec.)	2	0	0	0
Overall char (cm.)	2	6	2	8
Main char (cm.)	2	2	2	2
158° F — 16 hr. (wet)				
Afterflame (sec.)	0	0	0	0
Afterglow (sec.)	1	0	0	0
Overall char (cm.)	3	4	5	4
Main char (cm.)	2	2	2	3

It should be pointed out that research at this laboratory and elsewhere has shown that the efficiency of flame retardance is to some extent dependent upon the ratio of nitrogen to phosphorus that exists in the product insofar as cotton is concerned. By judicious selection of a flame retardant containing phosphorus and a thermo-setting resin containing nitrogen, the flame retardance of the products can be enhanced at a very low cost. A secondary benefit is the improved resilience achieved. The presence of a properly selected thermosetting resin also tends to make the flame retardant more permanent and stable and thus more difficult to remove from the cotton. It must be emphasized that the choice of the thermosetting resin cannot be made at random.

Effect of thermosetting resins

	Borated urea formaldehyde			Urea phosphate		
Sample No.	6	7	8	9	10	11
Percent add-on	7.0	7.0	7.5	6.6	6.6	6.0
Methylated methylol melamine percent	5	-	-	-	6	-
Dimethylol dihydroxy ethyleneurea percent		5	-	6	-	-
70° F. — 100 percent R.H.						
Overall char (cm.)	8	6	15	12	3	7
Main char (cm.)	5	2	3	2	2	2
100° F. — 100 percent R.H.						
Overall char (cm.)	10	3	F	12	5	8
Main char (cm.)	5	2	3	3	2	2

F = Flashed to top.

Effect of thermosetting resins

	Borated urea formaldehyde			Urea phosphate		
Sample No.	6	7	8	9	10	11
Percent add-on	7.0	7.0	7.5	6.6	6.6	6.0
Methylated methylol melamine percent	5	-	-	-	6	-
Dimethylol dihydroxy ethyleneurea percent	-	5	-	6	-	-
158° F. — 16 hr. (dry)						
Overall char (cm.)	10	6	F	F	8	8
Main char (cm.)	3	3	3	4	2	2
158° F. — 16 hr. (wet.)						
Afterflame (sec.)	19	0	9	0	0	0
Overall char (cm.)	8	4	10	6	5	4
Main char (cm.)	4	2	7	4	3	3

F = Flashed to top.

With some flame retardance such as the urea phosphate, methylated methylol melamine enhances the flame retardance, while with others such as the borated urea formaldehyde, it is detrimental. With the borated urea formaldehyde, dimethylol dihydroxy ethylene urea enhances flame retardance, but it is detrimental with the urea phosphate treatment. There does not seem to be a hard and fast rule as to which thermosetting resin might be the most beneficial. In some treatments a very small amount of the thermosetting resin seems to achieve both improved resilience and flame retardance.

The effect of increasing amounts of thermosetting resin on the flame retardance of products treated with urea phosphate and methylated methylol melamine is outlined below. Other data indicate that higher thermosetting resin contents do not further increase the resilience. Optimum levels of thermosetting resin with the urea phosphate flame retardant seems to fall between 3 and 5 percent add-on by weight of the cotton. Note that the performance under all test conditions is considerably better than the minimums arbitrarily selected.

Effect of increased thermosetting resin

Sample No.	A	B	C	D
Methylated methylol melamine percent	0	3	6	10
Urea phosphate percent	10	10	10	10
70° F. — 65 percent R.H.				
Overall char (cm.)	7	6	5	4
Main char (cm.)	2	2	2	2
100° F. — 100 percent R.H.				
Overall char (cm.)	8	10	5	4
Main char (cm.)	2	3	2	3
158° F. — 16 hr. (dry)				
Overall char (cm.)	8	7	5	4
Main char (cm.)	2	3	2	2
158° F. — 16 hr. (wet)				
Overall char (cm.)	4	7	4	5
Main char (cm.)	3	2	2	2

Frequently, enhanced flame retardance can be obtained when two different flame retardants are used. This premise has been explored in two different ways. In the first case, two samples of rawstock that had been treated with different flame retardants were blended at the 1 to 1 ratio at the feed to the garnett. The products under some test conditions had better resistance to burning than did either of the samples treated with a single flame retardant. However, the converse was also true, particularly after the samples had been soaked and dried before testing for flame retardance. The samples containing the blend of two previously treated rawstocks had less flame retardance than did samples from either of the individual treatments.

The second approach was to treat one batch of rawstock with a formulation containing two different flame retardants plus a thermosetting resin. In these cases the products generally showed properties approaching the performance of the best flame retardant, again with the exception that after wetting and drying the samples containing both flame retardants were somewhat less flame retardant than samples prepared with either of the treatments alone.

All of the samples that have been discussed to this point have been prepared by using the continuous padder described earlier. Paralleling these tests we have conducted a series of experiments wherein several samples were prepared by the use of a home-type washing machine. The chemical formulations for these washing machine tests duplicated formulations that had been used for the padder. In general, as given below, the test results for flame retardance at 70° F. and 65-percent R.H. and 100° F. and 100-percent R.H. are practically identical no matter which impregnation procedure was used. It is also apparent that the method of application did not affect the flame retardance characteristics at 158° F. or after soaking with water.

Effect of method of application

Treatment application	Immersion + agitation + centrifuge		Immersion + squeeze roll	
Treatment	UP 10 pct. BAP 12 pct. + DMDHEU 3 pct.		UP 10 pct. BAP 12 pct. + DMDHEU 3 pct.	
70° F. — 65 pct. R.H.				
Overall char (cm.)	7	4	4	5
Main char (cm.)	3	2	2	2
100° F. — 100 pct. R.H.				
Overall char (cm.)	6	6	4	6
Main char (cm.)	3	2	2	2
158° F. — 16 hr. (dry)				
Overall char (cm.)	9	6	3	5
Main char (cm.)	2	2	2	2
158° F. — 16 hr. (wet)				
Overall char (cm.)	8	8	5	7
Main char (cm.)	5	5	2	4

The possibility of achieving impregnation through the use of an inline liquid system has been explored. A technique that utilized a venturi principle was used. With this system, there is a tremendous turbulence at the throat of the venturi which results in extremely fast wet-out of the fibers. Contact time with the treating formulation can be varied by changing the length of discharge pipe. Treated fibers are collected on a screen which permits drainage, following which the fibers are passed through squeeze rolls or centrifuged to the selected wet pickup. Preliminary data shows that the throat size of the venturi limits the size of the clumps of fibers that can be fed to the system. More research is needed to make this system work smoothly.

A number of samples that had been prepared as long ago as 24 months were retested for flame retardance. These samples had been stored in the Industrial Wing of the building and subjected to the natural vagaries of temperature and humidity during the 24 months. In most cases the samples showed little if any loss in flame retardance during this time interval.

A preliminary cost study has been made on the application of flame retardants to cotton batting raw-stock. The study assumed that the equipment to be used would be housed in an already available and amortized building, and that a plant capable of processing 2,000 pounds of fibers per hour would be chosen. Using fiber cost figures of March 1969, it was calculated that the average price of fibers going into 1 pound of conventional untreated batting would be 7.76 cents, and that the manufacturing cost plus all incidentals and overhead would be 1.70 cents per pound. This would give a gross cost before profit or taxes of 9.64 cents per pound.

As outlined below, by using the urea phosphate treatment, the gross cost of a pound of flame retardant treated cotton batting is 11.97 cents, or 2.51 cents per pound of product more than conventional cotton batting.

Costs for flame retardance

	Fiber cost	Chem. cost	Mfg. cost	Total cost	Flame retardance cost
	Cents per pound of product				
Conventional batting	7.76	0.00	1.70	9.46	—
Urea phosphate	7.25	2.13	2.59	11.97	2.51
Borated amido polyphosphate	6.98	2.48	2.58	12.04	2.58
Dicyandiamide phosphoric acid	7.12	2.61	2.61	12.34	2.88

For the borated amido polyphosphate treatment, the gross cost per pound of product is 12.04 cents per pound. This is 2.58 cents more than conventional untreated batting.

For the methylolated phosphoric acid-dicyanamide derivative, the gross cost per pound of product is 12.34 cents, a differential cost for flame retardance of 2.88 cents per pound.

All of the above calculated costs include the writeoff of all of the necessary equipment over a period of 5 years. Longer writeoff times would reduce the cost per pound. For this 2,000 pound per hour capacity the equipment cost is estimated to be slightly less than $40,000. Larger capacity plants would not increase in cost directly, with a plant having a capacity of 4,000 pounds per hour probably costing between $50,000 and $60,000.

SUMMARY

Progress has been made toward the development of flame-retardant cotton batting products based upon the use of the vertical flame test. Using the urea phosphates, the propyl ammonium phosphate, the borated amido polyphosphates, and the methylolated derivatives of phosphoric acid-dicyandiamide, samples have been made that have afterflames of less than 1 second, afterglow times of less than 1 second, main char lengths of less than 2 centimeters, and overall char lengths of less than 5 centimeters. The cost of the treatments including capital expenditures, labor, overhead and other expenses, is between 2.51 and 2.88 cents per pound. If the standards for flame retardance when promulgated by the Department of Commerce or the Department of Transportation are more lenient than the limits that have been arbitrarily set for acceptability by the research team, the costs could be expected to be less than those cited above.

DISCUSSION

QUESTION: In the manufacture of Cotton Flote you spray the fibers with a mixture of acrylic and an internal crosslinking resin. I believe you spray in order to maintain loftiness of the array so that you get a superior product. I don't recall you mentioning that you tried any spraying experiments here for anything else that would indicate that flame retardance would be compatible with the Cotton Flote process?

MR. KNOEPFLER: Our current project deals only with conventional cotton batting. We have, however, reported on flame retardant Cotton Flote previously. Let me take a moment to review our findings. In the Cotton Flote process the flame retardant is applied simultaneously with the resins that are used. By this technique both improvement in resilience and flame retardance are obtained simultaneously. The add-ons of flame retardant for Cotton Flote are a little bit less than what is needed for conventional cotton batting to achieve an equal and acceptable level of flame retardance. Concerning the use of a spray technique for the application of flame retardance treatments to conventional cotton batting we have found that the economic picture is not good. In fact, if spraying is to be used, a plant might as well install the Cotton Flote process because the equipment costs would be almost equal. For example, if rawstock pretreatment for flame retardance is practiced, a gin-type dryer can be used. If spraying is practiced, an elaborate conveyor dryer similar to that needed for Cotton Flote would be required. This would then make a considerable difference in the cost of drying equipment.

QUESTION: To what extent has a batting industry adopted these techniques? Are they producing flame retardant products?

MR. KNOEPFLER: Unfortunately, I have to answer that by saying no. The cotton batting industry is waiting to see what the requirements — that is the standards — will be before they actually get into the production of these materials. We had rather hoped they would get started earlier and possibly contribute their own standards to the bureau which might be accepted. However, the industry is moving rather slowly in this direction at the present time.

QUESTION: Would you comment in regard to what our competition in the foam cushioning manufacturing is doing along the lines of flame retardance?

MR. KNOEPFLER: Yes. Practically every month when you pick up a technical journal you find articles dealing with flame retardants as applied to cellular foams and foam products and here, of course, lies our biggest competition — polyurethane foam. The reports from people who have seen the products, and what we can gather from technical articles lead us to believe the foam industry is spending a tremendous amount of money to try and develop flame retardant products, trying to sell them, trying to get people interested in buying them. At the present time, it seems that the chemicals required to give flame retardance to polyurethane foam will cost somewhere in the neighborhood of $1 a pound. Add-ons of 10 percent are required; so, on this basis then you might project a cost of approximately 10 cents a pound for flame retardance. I do want to point out that their technical problems are similar to ours. In some cases, worse — which may be to our benefit. By this, I mean products they have produced so far have less resistance to oxidative damage. In addition to that, the incorporation of a flame retardant into the dope or formulation tends to reduce the resilient characteristics of polyurethane foam products. They have their problems, but they are spending an awful lot of money trying to solve them.

QUESTION: You mentioned about standards being set by the Department of Transportation. Do you want to speculate when Commerce would set standards for bedding and upholstery?

MR. KNOEPFLER: I know the Bureau of Standards is taking a serious look at standards for bedding. The Department of Commerce through the National Bureau of Standards has a contract with Southwest Research Institute in San Antonio, Tex. They are making a whole series of tests to determine if a hazard exists, that is, how easy it is to set mattresses on fire, and how easy it is to set a bed on fire. From this, they hope to be able to get enough information so that they can establish what hazards exist and whether it justifies the writing of standards at this time. Dr. Pasaglia from the Bureau of Standards was down to visit us in late November. From what he told us, we feel reasonably sure there will be some standards promulgated sometime in the near future. It is difficult to pin down. I don't know whether they are talking in terms of 6 months or a year or two. But, it will come in the foreseeable future, I am sure. How severe the standard will be, we can't hazard a guess now.

WATER POLLUTION IN OIL MILLS

by

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(Presented by J. M. Ridlehuber)

Environmental issues and pollution controls are emerging as the dominant political force of the seventies. The public is frightened and no longer looks on water pollution as interfering with the "barefoot boy's swimming hole" or the sport fisherman but suspects that, coupled with expanding technology and exploding population, life itself may be threatened. Politicians are discovering that they can be elected on environmental issues alone. In Washington, the budget for Water Pollution Control has been tripled, with warnings that up to $10 billion may have to be spent on our sewage treatment. The immediate goal is for secondary sewage to eliminate bacterial pollution by late 1973 across the whole country. Even so, ecologists warn that nutrient enrichment (phosphorous and nitrogen) will have been so clogged with algae blooms as to kill most major waterways and lakes. Tertiary treatment, to remove nutrients, is still a long-range dream.

On the local level, sewage treatment plants that were designed for populations of the fifties and sixties and plagued with overworked facilities are demanding that industry either put in separate sewage treatment plants of their own or pay for the needed expansion of the community sewage treatment facility. Citizen groups are demanding that the limits of maximum allowable waste discharge be strictly observed. In New Jersey a fatty acid plant has been forced to ship concentrated waste waters by railroad tank car 25 miles to a treatment plant. A chemical plant on the Houston, Tex., ship channel has closed down rather than spend the money deemed necessary to meet waste discharge requirements.

A kraft paper plant in Georgia has spent $2.5 million or about 10 percent of the cost of the entire paper mill on a waste water treatment system that uses 670 acres of treatment lagoons. Water pollution has not been much of a problem for the small hydraulic and screwpress oil mills, however, with the trend to solvent extraction of oilseeds and to oil mill refinery systems for oil treatment integrated with the solvent plant, the industry should be warned that a sizeable portion of the expansion budget for the oil mill may need to be spent for pollution control. The sources of pollution as well as the limits for waste discharge from the plant will vary considerably with location. In Lubbock, Tex., the local ordinance forbids admission into the public sewers waste water with pH lower than 5.5 or higher than 9.0; a 5-day Biochemical Oxygen Demand (BOD) greater than 300 parts per million; containing suspended solids more than 350 parts per million; or in a volume of average daily flow greater than 2 percent of the average daily sewage flow to the city treatment plant. In addition the ordinance forbids a temperature hotter than 150° F.; more than 100 parts per million of fat, oil, and grease; any explosive solvent or naphtha; any solid or viscous substance capable of causing an obstruction to the flow in sewers; any toxic or hazardous material; or any material that will interfere with the proper operation of the sewage works or require extra attention or expense in the handling of such materials at the sewage treatment plant. If plant waste does not meet these requirements, the plant may either be asked to provide its own treatment facilities to lower waste water to the proper limits, or pay the city a surcharge based on the cost to the city of handling the objectionable materials. A suggested surcharge has been $1.65 per pound of BOD. A recently published article indicates that waste water from a plant handling vegetable oil fatty acids can run as high as 10,000 p.p.m. BOD. The surcharge for handling such material would be $1,370 per million gallons of waste water. A vegetable oil refinery with 2,000 p.p.m. BOD could be faced with a surcharge of $275 per million gallons of waste water, in addition to the loss of 8 tons of product per million gallons of waste water. The total cost to the plant would be more than $1,000 per million gallons of waste water, counting the value of product lost, or one dollar for each 1,000 gallons of waste water.

Sources of water pollution around an oil mill are many and varied as to type of pollutants. Pollution occurs from runoff of the mill property, and may occur during periods of rainfall, or when the buildings or driveways are hosed down during cleanup operations. Runoff pollution will be mostly organic fiber and protein, and will usually go to the storm sewer or natural outlet or stream. Good housekeeping practices and dust control will minimize the extent of pollution to runoff; however, there have been isolated cases of organic nutrients polluting a stream or lake that have been blamed on oil mills. It may be advantageous to consider diverting some cooling water or unpolluted process water into the storm sewer outlets, especially if the sanitary sewers are overloaded.

Pollutants of the waste water to sanitary sewers will generally fall into three categories; salt or mineral, oil and fatty material, and organic fiber and protein. In an oil mill, the concentration of salt can take place from boiler blowdown water or from the concentration of salt in water softener recharge effluent. The addition of phosphate and organic boiler water treatment compounds can add to the boiler-room waste problems, since they are designed to allow minerals to settle in the mud drum of the boiler from blowdown. These desirable qualities can cause trouble by settling in the sewer lines, so some kind of settling tank or pit should be provided to avoid stopped up sewer lines from the boilerroom.

Pollution from either oil or protein can occur throughout the oil mill as a result of spills, most prevalent in the loading areas. It is important that meal or feed loading areas be constructed so that any spills can be quickly and easily picked up before they are scattered. It is preferable to have the loading areas covered so that rainfall will not quickly wash the spilled material away. The oil loading area should be paved and should have a drain to a collection pit where any oil spills can be recovered instead of being washed away.

The solvent plant is naturally the source of most of the possible areas of water pollution in the oil mill. Excess cooling water or condensed steam that is not returned to the boilers will not normally be polluted and it may be desirable to divert these flows to the storm sewers unless they are needed to reclaim for other uses or to dilute less desirable wastes. A cost study comparing reuse of clean water with the cost of raw water should be undertaken in each individual mill. If water costs are high, the cooling towers should be made as efficient as possible. Water from the waste evaporator may contain traces of fat, fiber or protein, and should go into a separation pit. It is also recommended that solvent plant floors drain directly into a large pit, not only for recovery of any oil or solvent that may be spilled, but to contain the inflammable or explosive solvents that might be otherwise flushed down the drain.

Probably about half of the solvent cottonseed oil mills now have refineries, and many of the solvent soybean mills have degumming operations. The refinery has greatly increased the chances for water pollution. However, the water from the refinery area is most likely to contain recoverable fats that may more than pay for a water treatment system compared to a possible penalty or sewer surcharge if the water is not treated. Unfortunately, there is no easy, one-shot answer to the treatment needed. Waste water treatment is highly complex and any conclusions reached can only relate to waters under specific conditions. We can only recommend that where recoverable materials are present in the waste water, that concentration tanks or pits be provided, preferably where surface skimmers or scrapers aid in concentrating the material to be recovered. In the case of skimmers, it may be necessary to go into a second cone bottom settling tank for concentration of fats and oils. There are several companies that specialize in chemical treatments to aid the settling or floccing of materials for recovery. If the concentrated material is considered in enough quantity and valuable enough, filters or centrifuges should be installed to upgrade the value of the recovered material as oil or fat, or it may be added back to the meal as a pelleting aid or dust depressant. If the plant uses a water-washing step, there is sure to be considerable fat in the water from water-washing. Such fractions should be handled separately so that they will not be contaminated with other wastes before the fat can be recovered. If the plant is acidulating soapstock, water from water-washing or separator seal water that may contain fat should be added to the feed to the acidulation process in order to recover any fat present. Material skimmed from any pits going out of the plant that contains fat not worth refining should be added to the acidulation plant feed material. Also, as a conservation measure, and to cut down on the quantity of material needed to neutralize pH of sewage, dilution water needed for the acidulation plant should be recycled from settled acid water.

Soapstock acidulation is a new addition to oil mills, however, it is a natural part of the trend towards on-mill-site refining, and if planned with expansion to refining can be effectively merged with possible waste water treatment that will be needed anyway. In conclusion, although most oil mills have not been too much concerned about water pollution in the past, the problem will have to be faced as a part of the national awareness of pollution and demand for strict enforcement of sewage ordinances. We will be seeing more sophisticated processing equipment in the oil mills, and water treatment should be planned along with the new processes. Certainly the oil mill has a unique advantage to make water treatment pay for itself that will be denied to the conventional refiner of vegetable oil. Many opportunities to make a feed grade fat or addition to the meal stream exist for the oil mill, where without the feed stream, the conventional refinery might be forced to put recoverable waste into the sewage discharge. An engineering study should be made of material from settling tanks or chemical treatments to determine the potential for recovery, bearing in mind the advantage the oil mill has for recovery in the form of feed additives.

DISCUSSION

QUESTION: Would the oil in the clear bottle be edible or inedible?

MR. RIDLEHUBER: This recovery water is clear water. It might be suitable for reuse in the cooling tower or some other area.

QUESTIONER: I thought it was oil.

AIR POLLUTION AND ITS RELATION TO THE OILSEED INDUSTRY

by

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Air pollution is not a new problem. Patricians of ancient Rome complained because soot smudged their togas. In the Middle Ages, England's King Edward I had a subject put to death for burning coal instead of honest British Oak, and early Spanish explorers noted that a haze from Indian campfires hung over the Los Angeles Basin.

A long time ago, the Prophet Jeremiah told the children of Israel of Jehovah's anger at the way they had treated the promised land: "I brought you into a plentiful country to eat the fruit thereof and the goodness thereof, but when ye entered ye defiled my land and made mine heritage an abomination."

God's earth is still being despoiled. If anything, on a bigger scale than ever. The urgency of vast, all-out corrective measures was recognized by President Nixon in signing the National Environmental Policy Act on New Year's Day when he said: "It is literally now or never. The 1970's absolutely must be the years when America pays its debt to the past by reclaiming the purity of its air, its waters, and our living environment."

We have reached the point where there is no longer any question as to whether we are going to have clean air. We are.

At this point you may be asking yourselves "If air pollution has been around since the time of ancient Rome, why are we approaching the problem now with a sense of crisis?" Perhaps the answer to that question is that it seems to be our American habit to wait until things really get bad before we arouse ourselves to action. Maybe we have come to the realization that man's air supply is slowly but surely being poisoned.

Clean air is man's most urgent demand upon his environment. He can do without water for days and without food for weeks. But, he cannot hold his breath for more than a minute or two. Then he must breathe, even if it kills him — as it sometimes does.

The popular conceptions are that the earth floats in a vast sea of air and that we possess a super abundance of lifegiving oxygen. These are false notions. The atmosphere is finite. Approximately half of all the air lies within 3½ miles of the earth's surface. Nearly all of the air, and almost all of the cloud formation, is contained within the troposphere, that layer of the atmosphere which extends to an altitude of about 10 miles in the tropics and 6 miles in the temperate zone. Phrased another way, the amount of our air supply can be compared to the single coat of varnish on a globe.

It was in the primeval purity of this tropospheric environment that man's initial evolution took place. Until he discovered fire, the available pure air was, for practical purposes, unlimited. With the discovery of fire he started the process of air pollution as we now know it — a process which was to accelerate continuously as he learned with increasing efficiency how to release stored energy to modify his own local environment.

The industrial development in the United States during the late 1800's led to many new and different types of air pollution. Most of this pollution was due primarily to the use of coal and other materials to produce consumer goods and provide transportation. Thus the air pollution problem was first recognized as being primarily due to smoke, dust, and dirt.

During the past two decades other pollutants have been noted — carbon monoxide and dioxide, sulfur dioxide, the oxides of nitrogen, oxidants, organic gases, lead, asbestos, radioactive materials and many more.

Over 133 million tons of aerial garbage are now being dumped into the United States atmosphere every year. These pollutants are eating away at fabrics and metals. They are defacing buildings and spoiling crops. The Federal Government estimates that property damage alone amounts to $13 billion annually or about $65 per person. Included in this figure is a $500 million loss to agriculture.

The $13 billion property damage loss excludes the decline in real estate values in neighborhoods with air that is second class or less. Homes exposed to air pollution require more frequent painting and cleaning. Clothing and furnishings must be cleaned more often.

In the United States the quantity of pollutants thrown into the air is so fantastic that it is almost beyond expressing in understandable form. Each day motor vehicles alone discharge 250,000 tons of carbon monoxide, 30,000 tons of hydrocarbons, and 10,000 tons of nitrogen oxides.

To try to illustrate, every day these releases can provide a concentration of 30 parts per million of carbon monoxide gas to contaminate the air to a 400-foot height over an area of 20,000 square miles.

There is no longer any doubt that air pollution is a hazard to health. Prolonged exposure to low levels of some of the airborne toxic substances may have many health effects. Primary interest centers on the respiratory system through which these poisons easily enter the body. There is strong evidence that air pollution is associated with a number of respiratory ailments, including the common cold, bronchitis, asthma, and emphysema.

In some instances, air pollution has become a deadly killer on a large scale. In Donora, Pa., in October of 1948, smog settled down in the valley for 3 days. Twenty people died and over 4,000 of the 14,000 residents became acutely ill. In the winter of 1952 polluted and stagnant air caused over 4,000 Londoners to die in a single week. In 1953, New York sustained a week of smog which caused 200 people to die from its effects.

At present, there is no major metropolitan area in the nation without an air pollution problem of one type or another. Some of these problems are due primarily to automboiles, some are due primarily to industry, and some are due to a combination of sources. Air pollution is not a problem that affects only the larger cities; many smaller communities also have significant air pollution problems. These are usually due to the presence of one large industry or a group of small activities associated with one industry.

Three things are usually required for the creation of an air pollution problem: (1) There must be a source of pollution; (2) there must be a method of transportation; and (3) there must be a receptor affected by the pollution. We cannot change the weather conditions such as wind speed and direction that provide the method of transportation of air pollution and we cannot remove all the people, animals, or vegetation from the area affected by the air pollution. This leaves only one choice: The control of air pollution must be undertaken at the source.

The first program to control air pollution began in 1881 with the adoption of a smoke control ordinance in Chicago. Shortly thereafter, St. Louis, Cincinnati, and other cities also established smoke abatement programs. These early efforts established the often repeated concept that responsibility for air pollution control rests solely with the local and State governments. From 1930 to 1950 dramatic improvements were made in the control of smoke by some local programs operating strictly within the confines of this concept.

Other problems, along with still more public concern about air pollution led to the establishment of the first Federal air pollution program. In 1955 the Federal Government was authorized to aid local and state air pollution programs in the field of research and technical assistance. The continued growth of the national air pollution problem, coupled with the improved documentation of its subtle as well as obvious effects on the public health and welfare, demonstrated that local and state efforts were not adequate to cope with the challenge posed by the air pollution problem. Recognition of this fact was reflected in the passage of the clean air act of 1963 and in the subsequent amendments.

The Air Quality Act of 1967 is a blueprint for a systematic effort to deal with air pollution problems on a regional basis. It calls for coordinated action at all levels of government and among all segments of industry. The Air Quality Act also calls for the development and publishing of air pollution criteria indicating the extent to which a specific air pollutant is harmful to health and damaging to property, and for detailed information on the cost and effectiveness of techniques for preventing and controlling air pollution. The criteria and techniques for particulates and sulfur dioxide have been developed and published and additional pollutants are being considered at this time.

Many of you here this morning may have the mistaken idea that the Federal Government has set standards for air pollutants. I would like, at this time, to clarify this point. Federal regulation of air pollution from new motor vehicles has been in effect since 1965. However, the establishment of air quality standards is the responsibility of the individual States and the States will be expected to assume the primary responsibility for application of the air quality standard. If a State fails to set standards or if efforts at abatement prove inadequate the Secretary of the Department of Health, Education, and Welfare may take action to insure that appropriate standards are set or the Secretary may be empowered to initiate abatement action.

Many of the larger cities have been exempted from the State air pollution laws and these cities have enacted air pollution control ordinances which are more stringent than those of the state and are tailored to meet the needs of the urban centers.

With the exception of Mississippi, I believe most of the States represented here today have adopted air quality standards. Therefore let's examine these laws as they apply to the oil mill industry.

The air pollutants emitted by oil mills are particulates and odors and, in the case of solvent mills, hydrocarbons. Only a few state laws and local ordinances have set limitations on emissions of odors or hydrocarbons. Therefore, my remarks will be limited to particulates or dusts.

As stated earlier, the primary responsibility for dealing with air pollution has been placed at the state and local level. Most state control agencies have established air quality standards or objectives. These standards of ambient air quality define the limits of air contamination by particulates. Above these limits, the ambient air is declared unacceptable and air pollution control measures are required. These standards do not represent pollution concentrations at which there is a sharp demarcation between effect and no effect, rather the standards afford suitable assurance that no adverse effects occur.

I should point out that air quality standards for suspended particulates have been established for entire geographic regions or counties but they do not generally refer to specific sources of emission such as the cotton oil mill or any other specific industrial operation.

Typical of this type regulation is the standard for suspended particulate as set forth in the Tennessee Air Pollution Control Regulations. This regulation allows a concentration of 200 micrograms per cubic meter of air for suspended particulates in industrial areas and 80 micrograms per cubic meter in residential areas. These values are not to be exceeded more than 10 percent of the time during a 30-day period.

Another type of regulation for the control of air pollution by suspended particulate is an emission standard, which is a limit on the amount of pollutant that may be emitted from a source. This regulation of allowable emission based on process weight is used by Memphis and several other cities and by some county authorities. Allowable emissions are given in pounds per hour and range from about 0.5 pounds per hour for a process weight of 100 pounds per hour to 40 pounds per hour for a process weight of 60,000 pounds per hour.

The most recent trend in air pollution control regulations is to vary the process-weight rate to apply to a specific industry. This approach appears to be the ideal solution to equitable control standards. Extensive data on a specific industry would have to be obtained and evaluated before applicable standards could be set. For this reason, control regulations of this type appear to be at least 3 to 5 years in the future.

I recognize that it is sometimes costly and time consuming to comply with state and local regulations and codes. Yet the facts are abundantly clear — code enforcement, in many instances, is the only way in which we are going to achieve some semblance of air pollution control. Half-hearted regulations or less than full enforcement will yield weak results.

If your mill is found to be in violation of an air pollution control code or regulation you will be expected to take immediate steps to control the emissions. You will want to accomplish this in the most economical method possible. Perhaps these suggestions will be helpful. First, determine the degree of control necessary for compliance. Second, consult someone who is knowledgeable in air pollution control.

For years the cyclone has been the cornerstone for dust collection technology. It is simple, inexpensive, can be constructed of many materials, and has no moving parts. You probably have 25 or 30 of these cyclones on the roof of your mill. The collection efficiency is adequate for many problems. However, if the dust particle size is smaller than 40 microns the efficiency of these collectors will be in the area of 50 percent for conventional cyclones. High efficiency cyclones have a weight efficiency range of 50 to 80 percent on dust of particle size less than 5 microns and 95 to 99 percent efficiency range on particle sizes above 15 microns. High efficiency cyclones are generally considered to be those with a body diameter up to 9 inches.

A wet collector may be utilized for dust collection but a word of caution here — you may solve one problem and create others. You will probably end up with increased water usage, increased sewer charge, corrosion problems, a sludge disposal problem, or you may create a water pollution problem.

One of the oldest and most reliable methods for the removal of solid or particulate contaminants from air or gas streams is by filtration through fabric media. The fabric dust collector is a most versatile piece of dust removal equipment, being capable of 100 percent removal efficiency on submicron particles.

It is impossible for me to prescribe one type of control equipment that would be a "cure all" for all emissions. A cyclone might be efficient for some usage and again be totally inadequate in other areas of the mill. I would suggest that a testing program be undertaken to determine the concentration of suspended and settable particulates from oil mill operations. Information on particle size distribution is needed for estimating the fraction of dust that settles near the mill or remains suspended.

Source sampling for concentrations of particulate before and after dust and lint control systems would provide needed information on collection efficiencies and exit gain loadings for particulates. Perhaps this testing program could be a cooperative one whereby the information obtained could be shared throughout the industry.

If pollution is to be controlled at the source, this industry cannot escape its responsibilities. The initiative for research and for the development of control methods must be taken by you here today — for your own economic well-being as well as to meet your public responsibilities.

Control by either of the methods I have mentioned will be expensive. If you have to install control equipment you will be compelled to spend money that will not improve your product, that will not reduce your labor cost, nor will this expenditure increase the stock dividends. Therefore, I urge you to avail yourselves of the control techniques now available and to search for new and more efficient methods for combatting air pollution.

The purpose of all of our efforts is to enhance the quality of life for the people of today and for the generations to come. We want a humane environment. We want a benevolent environment. We want an environment in which the human being can live fully, in good health, and free from the constraints that limit his potential. If our society continues at its present rate to become less livable as it becomes more affluent, we shall surely end in sumptuous misery.

We can wait and court disaster, or we can take action now to clean the air.

DISCUSSION

QUESTION: One of the earliest curbs on our pollution was the use of a Cottrell electrostatic device, wasn't it?

MR. WHITE: Right.

QUESTION: Is this prevalent these days, or is this an outmoded method?

MR. WHITE: No sir, this is not an outmoded piece of equipment. There are many uses for it. All of the large power plants, generating stations, that use coal employ this type of device as the collection piece of equipment. It is expensive. That's the first thing. So, if you want to use it, use it only as a last resort. Second, the material being collected has to have a charge so that it can be collected on the electrostatic precipitator. But it is not an outmoded piece of equipment. In fact, since President Nixon has put out the emphasis on pollution, Cottrell's stock and all others have risen. It is very much in the news today and in usage.

PANEL DISCUSSION: OILSEED MILLING PROBLEMS

H. J. Witz, Producers Cotton Oil Co., Fresno, Calif., Chairman

COTTONSEED MILLING PROBLEMS

by

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The scope of the subject assigned to me can be as broad or as limited as one wishes to make it because oil mill problems are many and varied. However, at a meeting such as this one, it seems logical to concentrate, at least for the most part, on those problems on which research could find solutions. Let it be said also, that those problems outlined here and on which comments will be made will almost certainly not be a complete listing, but will perhaps serve to prompt discussion among the panel members as well as the other participants of this meeting. This, it would seem, is the purpose of panel members — to say enough on the subject under discussion to give direction and to prompt thinking and discussion among the participants, in order that together some course of action can be charted that will enable our industry to improve or at least sustain its economic condition. But now to the problems.

Perhaps the most basic problem, and it is not a new one, facing the oil mill industry is the shortage of raw material, cottonseed. We are still an industry of over capacity. A solution to this problem has been too long coming, as many dormant and dismantled oil mills can testify. It would seem that a solution to this problem would have to take at least two different directions: (1) Research towards the development of new and improved uses of cotton, and (2) development of methods to permit a reduction in the cost of producing a bale of cotton. Unfortunately, ours is an industry whose raw material is tied directly to another commodity, so that our industry can prosper no better than that other commodity, cotton, that supports it. We have been encouraged by the dollar a bale program recently begun and are hopeful that a real breakthrough can be accomplished in these areas.

Another problem that should be of concern to our industry is the apparent loss of recognition of the premium qualities of cottonseed oil. It has been said in recent months by the head of the Product Research and Development Department of one of the leading processors of vegetable oils that from their company's standpoint, because of developments made and solutions found to the problems peculiar to soybean oil (our chief competitive vegetable oil) that cottonseed oil is no longer a premium oil but is just another vegetable oil that is interchangeable with soybean oil. We know, however, that up to this point in time, cottonseed oil still sells at a premium over soybean oil. How long we can expect this condition to exist is difficult to say. We should recognize, though, the importance of research and development towards the objective of maintaining the premium qualities of cottonseed oil as well as new end uses for this, our most valuable product.

Cottonseed meal is still not without its problems. While it is true that in some isolated areas, cottonseed meal today is sold into markets that just a few years ago were limited to soybean meal, it is also true that the bulk of the cottonseed meal today still goes into selective markets because of the toxicity of cottonseed meal for single stomach animals. Much work has been done in this area to develop additives to nullify the toxic effects, to develop glandless cottonseed, and to learn of processing conditions that will minimize this toxicity, but the day when we can say that cottonseed meal is completely interchangeable with soybean meal for all applications still seems uncomfortably far away. This day must and will come, however, if we will but stubbornly refuse to give up and press forward with hard work and patience.

Second cut lint has given oil millers its share of headaches, also. It's a real tragedy that our country has to go to war in order to take the pressure off the oil mills to produce a premium grade second cut lint, but that seems to be what has happened. All of us remember that just a few short seasons ago, we were under terrific pressure to produce a second cut lint low in what we came to know as "dirt count." Oil mills did all sorts of things that they never had to do before in an attempt to make a second cut lint that would move into the available market. Then the Vietnam war came along with its enormous requirements of gunpowder and the pressure seemed to be off again. Now we see hopeful signs that the Vietnam war is cooling off and maybe even coming to an end, so we can expect to see in the not too distant future, a return to strong emphasis on high-yield, low dirt count, second cut lint. We know that a large part of the dirt count problem could be solved if some method could be found to remove cockleburrs from cottonseed prior to the delinting operation. This will not be an easy task, however, because the physical characteristics of the cockleburr causes it to cling tightly to whatever cottonseed with which it may come into contact. It would seem that the task of removing particles of the cockleburr from second cut lint after the delinting operation has occurred would be even more difficult. It is quite possible that whatever the method of removing the cockleburr, whether it be from

the seed prior to the delinting operation, or whether it be from the second cut lint after the delinting operation, it will be some method distinctly different from any of the conventional methods of cleaning cottonseed or second cut lint with which we are familiar. However, in a day and age in which man can go to the moon and return with split second precision, such as we have seen demonstrated on two different occasions, surely the removal of cockleburrs from cottonseed or second cut lint should not cause us to panic. If oil mills are to continue delinting cottonseed in the conventional manner, then the cockleburr problem is an area in which much work must be done.

Now I'd like to comment on what in my judgment is to become an oil mill's greatest problem in the decade of the seventies. Were you to ask any oil mill superintendent here today, or probably any oil mill manager as well, to name his greatest operational problem even today, it is very likely that his answer would be labor. During the last two or three seasons this problem has progressively worsened. I see the beginning of this problem as having been caused by the last change in the Wage and Hour Law in which the minimum wage was progressively increased, and our industry's exemption from overtime payment was progressively eliminated. The oil mill industry, as are most industries that are processors of an agricultural commodity, has always been an industry of relatively low hourly rates of pay when compared to more sophisticated industries. As long as our industry was exempt from overtime payments, however, we were able to compete in the labor market with other industries by working longer hours resulting in comparable total take-home pay with these other more sophisticated industries. Oil mills had operating crews with years of experience on which to rely. During the past two or three seasons, however, with oil mills attempting to eliminate or at least minimize payment of overtime by working reduced hours in order to hold costs in line, even with increased hourly rates of pay, total take-home pay has been reduced, resulting in terrific turnover of labor. Once oil mills were on the same 40-hour basis as other industries, then it was only natural for oil mill labor to seek employment where higher hourly wages were paid. It seems to me that the impact of Federal legislation on the oil mill industry increasing the minimum wage and eliminating exemption from overtime payment would have been far less damaging if the minimum wage had been increased in successive steps first, followed by elimination of the overtime exemption in successive steps rather than to make the two coincide as was done. This would have permitted wage rates to be increased to a level prior to the elimination of the overtime exemption that would have softened the effect of reduced working hours. This, though, is now history. We are now faced with operating an industry with large requirements of man-hours per unit of production when compared to other industries, especially when compared with our chief competition in the vegetable oil and protein industry, namely the soybean industry, at a time of full employment and at a time when manual labor requiring the "sweat of one's brow" is most unattractive.

If yours is the typical oil mill, then it is very likely that your labor cost represents at least 50 percent of your variable costs, or of those costs over which you have some control. These variable costs would include such things as laboratory expense, repair costs, power, fuel, and miscellaneous operating supplies. It is not hard to see then, the magnitude of the problem. Taking a further look at this labor matter, one sees that of the total labor costs, the packaging and handling of products represents approximately 33 percent, and the lint room operating labor represents some 20 percent. Included in the packaging and handling of products are meal sacking and handling, hulls sacking and handling, and lint baling and handling. It is not difficult to see then, where the labor problem areas are concentrated. We always like to think that things are going to get better, but let's take a look at some of the predictions being made concerning the labor market for the decade of the seventies. First, the pressure is on for a 4-day work week. The 40-hour, 5-day work week has become standard, and the 35-hour work week is not unusual and so the prediction is being made that the American worker in this decade will be phasing into a 4-day week and will be depending more on brains and knowledge and less on muscle. It is predicted that by 1975 or 1980 at the latest, the majority of the American labor force will be professional, managerial, and technical, or the so-called knowledged worker. It has been predicted that in this decade, total employment growth is expected to increase 25 percent. Looking at employment growth by categories: Professional and technical workers are expected to increase about 50 percent; managers, officials, and proprietors about 20 percent; sales workers about 30 percent; craftsmen about 25 percent; semiskilled workers about 10 percent; service workers about 40 percent; but laborers, excluding those in farming and mining, are expected to change very little. These employment trends are influenced, of course, by the fact that we can expect a better educated labor group as well as the phenomenal, technological developments experienced in the past decade and those that we can expect in this one. These trends should give us cause for concern since our industry is one requiring a substantial amount of manual labor. You can call it innovation, creativity, research and development, or whatever, but it would seem that it is going to be necessary that we put our minds and energies to developing ways to take manual labor out of oil milling. Our lint room operation, for instance, has changed very little since the inception of our industry. It may be a mechanical process or it may be a chemical process, but there must be some better way to perform the delinting process. The packaging and handling of products, as previously mentioned, is another problem area. Better methods for packaging and handling of our products are needed which would be adaptable to automation or to

put it in simpler terms, elimination of labor requirements. This may take the form of a different type package from what we have been using or perhaps a different size package, but it would need to be some type of package better adaptable to assembly line type of handling.

These are at least part of the problems that will face oil millers in the decade of the seventies. None of them are new, but all of them take on increased importance each year. We must face up to them if our industry is to be the industry that all of us want it to be.

QUALITY CONTROL IN OILSEED MILLS

by

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In looking over the program of all previous clinics, I get the feeling that everything has already been said on this subject. Did you know that almost 75 percent of all papers given at these clinics have dealt with some phase or another of quality control? We don't need to labor the point of its importance then. I believe we all recognize that the degree to which we control quality determines whether we make a reasonable profit or go bankrupt.

Quality control cannot be a sometime thing. It must take on the characteristic described by an old and faithful maid in a family containing a number of children. The lady of the house had noticed that a lack of enthusiasm was beginning to show up in Gertrude's work and sought to find the reason. "Gertrude," she said, "when you started working for us you told us that you enjoyed doing housework, but lately you don't look as happy as you used to. What's wrong?" "Well, Miss," Gertrude replied, "I do like to cook, and mop, and dust, and I even like to wash and iron, but lately it just seems so daily."

Don't expect any startling disclosures, nor even any bits of information that you don't already have. I can only hope to remind you once again of the myriad details of your daily work which go to make up "Quality Control in Oilseed Mills."

Let's start with raw materials. Normally, an industry buys only raw materials that will meet certain specifications which are required to produce a quality end product. The oil mill industry, however, being somewhat abnormal, will buy almost anything that looks remotely like a cottonseed or soybean with or without fuzz. In fact we'll almost come to blows over who gets the privilege of buying them. Let me hasten to add that this viewpoint belongs to those who are in the manufacturing side of the business, while the commercial people, I'm sure, feel that the manufacturing group can, and quite frequently do, make the lousiest products from the finest of raw materials. Understanding each others problems is an excellent place to begin controlling quality.

Seed and bean buyers can and do buy selectively wherever possible to improve the quality of products. For example, treated planting seed or beans are rejected as unfit for oil mill use; beans of low protein or low oil content are bypassed in favor of those having higher protein or oil content. Oil mill operators likewise are receptive to the quality needs of the products salesmen. They strive to get the optimum quantity of quality products from each ton of raw material.

Cottonseed having the same grade will often differ widely in value. One reason for this (and it is almost completely ignored by everyone) is the amount of physical damage inflicted on the seed during harvesting and ginning. In the 1965 clinic Mr. Helmer (2) from the Seed Technology Laboratory of the Mississippi Agricultural Experiment Station gave data to show the direct relationship between seed moisture and gin damage, and between ginning rate and gin damage. He also pointed out that recent studies revealed an average of approximately 5 percent damage is inflicted on the cottonseed by mechanical harvesters. On soybeans, the combining operation can also cause heavy damage by cracking or breaking the beans. Perhaps at some future date, this type of damage, which obviously reduces product value, will be measured and put into the grading system for cottonseed, just as splits are now a part of the soybean grading system.

Unloading has more bearing on quantity of seed and beans received than it does on quality, but there are some points which need to be watched in order to avoid quality problems. A pneumatic unloader on cottonseed will hull the seed if the baffle in the top of the vacuum box is not adjusted to the correct height. Sharp, worn places in the vacuum box wear plate will also hull seed. And, of course, any spillage of beans or seed during unloading, not promptly and carefully cleaned up, can create quality problems in addition to a physical loss.

Storage of seed and beans is a very important part of the process as far as quality is concerned. First of all, the storage units must be clean and completely free of insects and rodents before any materials are put into them. In some of the older types of seed houses, this is time consuming and expensive, but necessary. Secondly, as Walton Smith (5) pointed out in a paper at the 1966 clinic, it is most important to segregate "low quality" seed or beans and know where they are. Failure to do this can cause widespread deterioration of good quality seed or beans, as well as some surprises in processing.

Proper cooling of stored raw materials has only received its deserved attention in the past few years. Excellent papers have been presented at the clinic on this subject by Walter Johnson (3) 1960, W. B. Harris (1) 1961, James D. Helmer (2) 1965, M. C. Verdery (7) 1966, and L. L. Smith (4) 1969. We now know how to

cool for best results and we also know how to do it most economically. In our zeal to cool adequately we have sometimes gone too far, particularly on beans. This would necessitate the use of excess steam to bring them back up to conditioning temperature. Some of you may be having this problem right now after all of this good cooling weather we have had!

It is most important to avoid cracking the hull or mashing the seed when emptying the storage unit. Many of us now use these huge earth moving machines for feeding seed from storage, and we must insist that the operator keep his path as free of seed as possible.

Cleaning of seed and beans must be thorough if we are to get the maximum prices for our products. Dirt and sand carried through the process will reduce the quantity of high protein soybean meal that can be made. It will also cause excessive wear on cracking and flaking rolls and on all conveying equipment. Foreign material remaining in cottonseed going to the linters causes trashy first cut lint and low cellulose, trashy second cut lint. It may also cause torn up saws, wrecked hullers, and high maintenance generally.

Unfortunately, linters are not as "automatic" as we would like for them to be. Until some other way is found to recover lint from cottonseed, large chunks of our manpower and maintenance money must be spent in the lint room. Not only must the linters be in good mechanical repair in order to make quality lint products but they must also be kept in proper adjustment by skilled people. Changes in linter adjustments are necessitated almost daily because of one or more of the following:

1. Linter market changes.

2. Change in percent lint on seed being processed.

3. Change in foreign material in seed being processed.

4. Decreasing saw diameters.

No, we can never expect to be able to set and forget the lint room.

One point in the lint room which needs emphasis in my opinion, is the cleaning of lint, and most importantly, the final disposition of the fractions from the cleaners. It may be heresy as far as lint brokers and bleachers are concerned, but there can be such a thing as too much lint cleaning for maximum product value. No one set of rules can be given for the proper disposition of fractions, but such things as market demand, price differential between first and second cut lint, and between second cut and hulls will determine the best disposition at any given time.

Hulling of cottonseed may not be considered important from a product quality standpoint, but I need not remind you that a bundle can be lost with dull huller knives, clogged shaker screens, poorly adjusted aspiration nozzles, and the like. The quantity of hulls going with the meats is always critical, whether your plant is mechanical press, or solvent extraction.

Ideally, a soybean should be cracked into six equal portions. It is my opinion that we should sin in the direction of cracking too coarsely, if we can't accomplish the ideal. A coarse crack will reduce flaking roll capacity and that is about all, while a crack that is too fine will cause poor drainage and thus poor extraction, and probably a reduced quantity of high protein meal, especially on a mill using the tail end system.

Conditions and moisture temperatures are critical. Flake structure, residual oil, refining loss, and color are all affected significantly by conditioning temperatures and moisture as well as time. This is true to a greater degree for cottonseed than for soybeans. Keep the range narrow for best results.

There is almost no latitude allowed in flake thickness for highest product quality and value. Generally speaking, we want the thinnest flake possible and will maintain its structure during conveying and extraction. For cottonseed this is generally 0.006 to 0.008 inch and for soybeans 0.009 to 0.011 inch. In the mechanical press mills on cottonseed, 0.010 to 0.012 inch is satisfactory.

I won't try to specify any of the details of cooking ahead of mechanical presses. Some use stack cookers, some horizontal, and some of both. In all cookers, one point that may be overlooked is the disastrous effect on processing which bent sweeps and agitators will have. The heating surfaces must be kept clean and free of any meats buildup.

The quality of maintenance on mechanical presses is probably the biggest single variable in quality control in the press room. Load, downspout moisture, etc., are of course quite important but these are tangibles which can be routinely measured and controlled, while maintenance is generally the opinion of one man about what needs to be done.

In solvent extraction units, equipment manufacturers can be relied on for capacities, flow rates, temperatures, pressures, etc., which will give satisfactory results. So start with these, then carefully vary one at a time until the optimum set of conditions is found.

Desolventizing and toasting flakes is much more than that. Time, temperature, and live steam addition determine such important quality features as color, protein solubility, and on soybean flakes, urease activity.

In grinding flakes, the trend seems to be toward single screening prior to grinding. This system demands better maintenance of hammer-mills and more frequent checking of the fineness of the finished product.

One of the most difficult of all quality control problems is that of protein control. Also, more money is probably made or lost at this point than anywhere else in the processing. No perfect system has yet been devised for guaranteeing correct protein in all meal produced, but I would like to refer you to W. G. Quinn's (6) paper "Protein Control of Meal Shipments" given at the ninth clinic in 1960 in which he stated, "Supervision of details is one of the most important means for obtaining uniformity."

Finally, pest control and sanitation must be uppermost in the minds of all mill personnel, if quality control is to be a reality.

Let me leave you with two questions: (1) Are you taking proper samples at the correct places, and at adequate frequencies to correctly measure quality? and (2) do you periodically review each piece of equipment and each process in your mill, to make certain there isn't something better available now?

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EFFECT OF PROCESSING ON THE CYCLOPROPENES IN EDIBLE COTTONSEED OIL

by

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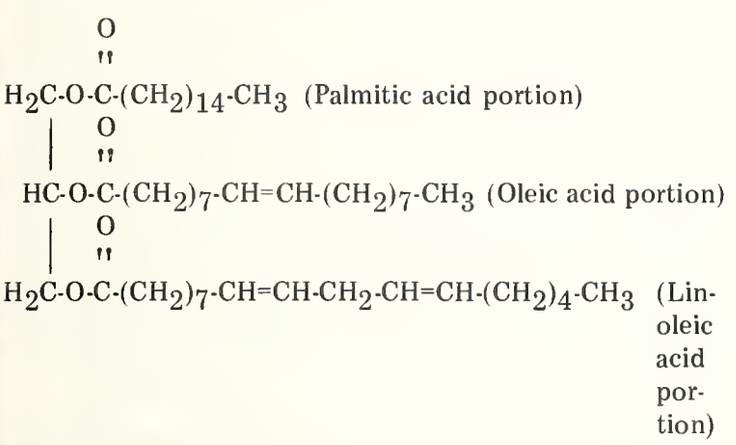
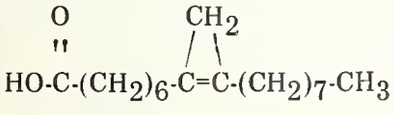
Cottonseed oil, like other natural fats and oils, consists of compounds of glycerol and fatty acids. The fatty acid portion comprises about 90 percent of its total weight. The chemical structure of a typical molecule of the oil can be represented as follows:



Where H represents an atom of hydrogen; C, an atom of carbon; and O, an atom of oxygen. The fatty acids of cottonseed oil consist of approximately 50-percent linoleic, 25-percent oleic, and 25-percent palmitic. Minor amounts of other fatty acids are present. The cyclopropene acids, malvalic and sterculic, amount to about 1 percent.

Malvalic acid has the following structure:



Sterculic acid, which is present at a level below that of malvalic, is like malvalic except that it contains an additional $-CH_2-$ group.

The cyclopropene acids are of interest primarily because they are quite active physiologically, even at the low concentration found in cottonseed oil (5). If they are fed to laying hens at a level of a few milligrams per day and the eggs are stored, the yolks become enlarged and the whites become pink. Analysis of the fats in the enlarged yolks reveals a greatly increased ratio of stearic to oleic acid. Thus, in one series of experiments (7) the ratio of the percentages of stearic to oleic acid in the yolk fats for hens fed corn oil was about 10:37, while that for hens fed cottonseed oil was about 20:23. It has also been demonstrated that the feeding of cyclopropene-containing fats to animals increases the ratio of stearic to oleic acid in the depot fats. Apparently, the cyclopropenes on ingestion attack the sulfhydril groups of some body enzymes and change the metabolic fate of the fat (3).

Knowing about the presence of cyclopropenes in cottonseed oil and knowing about their marked physiological activity, it becomes obvious that the behavior of the cyclopropenes during the conventional processing of cottonseed oil is of more than academic interest. There is a need to know the effect of refining, bleaching, winterization, hydrogenation, and deodorization.

Refining. — Conventional refining consists essentially of mixing a dilute solution of alkali with the crude oil, warming the mixture, and separating the aqueous phase. The alkali reacts with the free fatty acids to form soaps, which separate from the oil; gums and proteins are hydrated; and color bodies are removed from the oil, both by reaction with the alkali and by adsorption. Unfortunately, the cyclopropene moiety is unaffected by the alkali used in refining, and this operation does not decrease the concentration of cyclopropenes in the oil.

Bleaching. — The color bodies left after refining are further reduced in amount by heating and mixing the oil with an adsorbent, generally a special clay. If the bleaching is conducted under vacuum, temperatures between 170 and 180° F. are frequently employed. Temperatures between 220 and 240° F. usually are employed for bleaching at atmospheric pressure. The heating destroys a small proportion of the cyclopropenes by thermal degradation. For an appreciable destruction by heat alone, a considerably higher temperature must be employed. Simply heating the oil for 60 min. at 435° F. destroys about two-thirds of the cyclopropenes (6). Reactions at the surface of the adsorbent are responsible for most of the destruction of the cyclopropenes. Vacuum bleaching of cottonseed oil with 4 percent Fuller's earth for 30 min. at 250° F. destroys about 50-percent of the cyclopropenes (6).

When alumina, an adsorbent not now used in the large-scale processing of vegetable oils, is treated with sulfurous acid and then used to bleach cottonseed oil, all cyclopropenes are destroyed after 30 min. at 435° F.

Alumina treated with other acids, such as hydrochloric and sulfuric, also was quite effective (6). Other variations of treatment with acidified adsorbents are, of course, possible. Representatives of one company have stated that they were able to completely destroy cyclopropenes by bleaching with an acidified clay under otherwise conventional conditions. Should it be deemed desirable at some future date to eliminate cyclopropenes from edible cottonseed oil, some form of bleaching with acidulated adsorbent would be ranked high among available processes.

Winterization: — Most of the cottonseed oil produced is winterized to make salad oil. Winterization consists of slowly cooling the oil to effect partial solidification and then separating the solid and liquid phases. One would not expect this treatment to destroy cyclopropenes, though one might expect that the cyclopropene-containing glycerides, being lower melting would concentrate in the liquid or salad oil fraction. This separation probably does occur to a limited extent, but for practical purposes the content of cyclopropenes in the salad oil fraction is virtually unaffected.

Hydrogenation: — It has been known for many years that the hydrogenation of cottonseed oil to make shortenings and margarine stock destroys the positive response of the oil to the Halphen test (4). Subsequently, it was demonstrated that cottonseed oil gives a positive Halphen test only when cyclopropenes are present.

We conducted an investigation to establish just how much hydrogen was needed to destroy the cyclopropene moiety (8). Only 1.5 percent of the amount of hydrogen required for complete hydrogenation of the oil was sufficient for complete destruction. This is very little indeed, about 0.013-percent hydrogen based on the weight of the oil. Subsequently, research workers at the laboratories of a large oil processor confirmed these findings (2). They devised a continuous hydrogenation procedure in which the cyclopropenes could be destroyed in 2 min. at a temperature between 150 and 315° F. with practically no hydrogenation occurring.

We conducted an investigation to establish the relative rates at which the cyclopropenes hydrogenated and to establish the nature of the reaction products formed[1/]. The reactivity of the cyclopropene acid groups to the linoleoyl groups was better than 100:1 at 125° F., which is well below the temperatures used in commercial hydrogenations. At 265° F., which is in the range of commercial hydrogenations, the ratio was 7:1. The ratio decreased to 2:1 at 355° F. However, at the latter temperature thermal degradation became appreciable and increased the overall rate of disappearance.

Contrary to what had been reported previously in the literature, we found that at the temperatures normally used for plant-scale hydrogenations the cyclopropenes are not hydrogenated entirely to cyclopropanes, which may or may not react further. Instead, we found at least nine different reaction products, the major one being a methyl-substituted monounsaturated fatty acid group. The structure of the major products resulting from hydrogenation were established.

In another investigation the discovery was made that palladium catalysts, which are sometimes used in laboratory hydrogenations and which have been advocated for plant-scale use, were able to destroy the cyclopropenes in the absence of hydrogen (9). In other words, it was sufficient just to add the catalyst and heat the oil. Temperatures of about 300° F. and a time of 60 min. were found best. The amount of palladium could be as low as 0.02 percent. The reaction was truly catalytic and the palladium could be recovered and reused. When the catalyst became poisoned, it could be regenerated by washing with an alcoholic solution of an alkali. The structures of the degradation products formed by the palladium treatment were determined. It was further determined that the treated cottonseed oil remained unchanged in flavor, odor, and appearance.

Deodorization: — The final process to which virtually all edible oils are subjected is deodorization, a low-pressure, high-temperature steam distillation. Deodorization would be expected to destroy cyclopropenes because of the high temperatures employed and because small amounts of free fatty acids are formed and removed continuously during the process. But it remained for a group at our laboratory to show that the cyclopropenes of cottonseed oil could be destroyed completely by a prolonged, batch-type deodorization (7). Adding about 1-percent free fatty acids from cottonseed oil increased the rate of destruction. However, the conditions for complete destruction were found to be somewhat drastic. In a small laboratory deodorizer in which the oil could be heated rapidly, 2 hr. at 450° F. were required when no free fatty acids were added.

In a pilot plant deodorization (1), where 3.5 hr. were required to bring the oil to 450° F., the content of cyclopropenes was reduced from an original value of 0.53 percent to a final value of 0.03 percent by the time the temperature reached 450° F. When free fatty acids were added, the cyclopropene level in the oil was reduced to less than 0.01 percent during the 3.5 hr. required to raise the temperature to 450° F.

[1/] Feuge, R. O., Zarins, Z., White, J. L., and Willich, R. K. Presentation at IX Congress of the International Society for Fat Research, Rotterdam, the Netherlands, September 16-21, 1968.

SUMMARY

The physiologically active cyclopropene acids, malvalic and sterculic, which occur in cottonseed oil at a level of about 1 percent, are chemically quite reactive and can be partially or completely destroyed by some of the customary processes to which edible oils are subjected. Related processes can also be devised for destroying these cyclopropenes.

Bleaching, the first of the cyclopropene-destroying processes encountered in conventional purification, can rupture the cyclopropene ring when highly activated adsorbents are used or can polymerize the cyclopropenes if high temperatures are employed. Use of acidified adsorbents can result in complete destruction of the cyclopropene moiety. Treatment of cottonseed oil with palladium deposited on carbon or diatomaceous earth, a bleaching-like process, completely destroys the cyclopropenes.

Hydrogenation is highly effective in converting the cyclopropene moiety into other structures. The ease with which hydrogenation can destroy cyclopropenes and the nature of the resulting compounds have been established.

Deodorization, the final process customarily used in manufacturing edible oils, destroys the cyclopropenes both by heat polymerization and by reaction with free fatty acids, which may be added deliberately or formed in situ during the deodorization.

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PESTICIDES AND OTHER CONTAMINANTS

by

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The cottonseed and other oilseed processors face numerous contamination problems. I hope that they are theoretical rather than actual ones for members of this audience. So that they remain so, I welcome this opportunity to discuss some of these problems and to offer suggestions to prevent their occurrence.

Under the Food, Drug, and Cosmetic (FD&C) Act there are no "contamination" charges per se. The term used is "adulteration." The Act also defines "food" as articles used for food and drink by man and animals and the articles used for components of any such articles. Thus, contamination or adulteration problems affect not only products intended for human consumption but the byproducts used in animal feeds.

In my experience the most likely contaminants to be found in oilseed products and the basis for a charge of adulteration under the FD&C Act are these:

1. Insect, rodent, and bird parts and excreta.

2. Pesticide residues in excess of established tolerances or for which no tolerances have been established.

3. Food additives which do not conform to exemptions which are in effect or regulations prescribing conditions under which the additive may be safely used.

4. Poisonous or deleterious substances, such as mycotoxins, which may render the food injurious to health.

Under the Act, it is not necessary that contamination be found in the food. Under Section 402(a) (4) a food is deemed adulterated if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth or whereby it may have been rendered injurious to health.

Filth contamination problems are well recognized. I shall forego a discussion of this area except to point out that an attack mounted without due care against insects, rodents, and birds can lead to the problem of contamination with pesticide chemicals.

A pesticide chemical is an "economic poison" as defined by the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The term covers substances or mixture of substances intended to prevent, destroy, repel, or mitigate insects, rodents, fungi, weeds, and other forms of plant or animal life or viruses (except viruses on or in living man or animals), which the Secretary of Agriculture declares to be pests; and those intended for use as a plant regulator, defoliant, or desiccant. A pesticide chemical may not be shipped in interstate commerce without prior registration by the USDA. Before it can be registered the pesticide must be shown to be safe when used as directed and effective for the purpose claimed on the label. Under the Pesticide Chemical and the Food Additive amendments to the FD&C Act a safe tolerance must be established by the Food and Drug Administration (FDA) when the registered uses result in residues in or on food and feedstuffs.

At the risk of over simplification let me say: (1) pesticide residues in or on raw agricultural products (for example, cottonseed) require a pesticide tolerance or an exemption from the requirement of a tolerance; (2) pesticide residues in processed foods (for example, refined cottonseed oil and cottonseed meal) require a food additive tolerance or exemption therefrom. However, when the residues occur in processed foods due to use of raw agricultural commodities containing legal levels of pesticide chemicals, the processed food is not considered adulterated, provided good manufacturing practice has been followed in removing residues during processing and as long as the concentration of the residue in the processed food when ready to eat does not exceed the tolerance for the raw commodity. For example, if a tolerance of 4 p.p.m. has been established for DDT on cottonseed, and cottonseed containing 4 p.p.m. or less is processed, cottonseed oil containing 4 p.p.m. DDT is not adulterated. If processing concentrates the residue to the extent that the tolerance for the raw produce is exceeded, the processed food is adulterated unless a higher residue tolerance is authorized by a food additive regulation.

Of course, not only pesticide residues are food additives. A food additive is any substance the intended use of which results or may reasonably be expected to result in its becoming a component or otherwise affecting the characteristics of any food, and which is not generally recognized by qualified experts as safe. The conditions under which an additive may be used are prescribed in food additive regulations. An example of a regulation of interest to this group is the one covering the additive:

"Partially defatted, cooked cottonseed flour or similar products derived from cottonseed intended for human consumption." Its regulation (121.1019) specifies:

"The food additive partially defatted, cooked cottonseed flour may be used in or on food in accordance with the following prescribed conditions: (a) The additive is derived from decorticated, partially defatted, cooked, ground cottonseed kernels prepared so as to meet the following specifications:

"(1) Free gossypol content not to exceed 450 parts per million.

"(2) It contains no added arsenic compound and therefore may not exceed a maximum natural background level of 0.2 part per million total arsenic, calculated as As.

"(b) To insure safe use of the additive, the label of the food additive container shall bear, in addition to other information required by the act, the name of the additive, 'partially defatted, cooked cottonseed flour'."

Food with pesticides residues and food additives are unsafe within the meaning of their respective sections of the Act (408 and 409) if they do not conform to the tolerances and regulations. The underlying philosophy in dealing with these added toxic materials is that the amount added to the nation's food supply should be kept to the absolute minimum necessary to get the job done, with an adequate margin of safety provided.

However, foods containing aflatoxin, the highly poisonous substance produced by the mold, Aspergillus flavus, are deemed adulterated under Section 402(a)(1) of the Act. The charge against the product would be that it "contains a poisonous or deleterious substance." As you know, aflatoxin has been found in peanuts and cottonseed, among other products.

After this legalistic preamble, I would like to descend to practicalities. Here are some contamination problems I have known:

Misuse of pesticide chemicals on stored seeds in the food processing area and on the food processing machinery. Several years ago we had a rash of incidents involving chlordane residues in cottonseed meal. Analysis of scrapings from the bins and floors and debris from the equipment showed high levels of chlordane present. Chlordane is a residual pesticide not approved for use in food plants. The pest control operator was using malathion. Finally we ran a sample of malathion left at the plant to do "touch up" control work. It contained about 1,000 p.p.m. chlordane.

Inspection of a firm at the end of the season showed a plant almost saturated with paradichlorobenzene. As I recall, no oil was involved but there were feed byproducts on hand and residual feed materials in the system which would eventually be bagged.

Misuse of rodenticides around stored feeds. Over the years we have encountered a number of instances where liquid rodenticides in open cups were placed precariously near bags of feeds. Included was the highly poisonous 1080 for which no antidote is known.

Reuse of pesticide-treated seed bags for shipping feeds and feed components. Credit for uncovering this dangerous practice goes to Louisiana State Department of Agriculture personnel. They found that cottonseed meal shipped in bags originally used for aldrin-treated rice seed absorbed enough aldrin to cause illegal dieldrin residues in milk. Louisiana has changed its regulations to prevent the practice.

Diversion of treated seed to food use. Although I know of no specific instance involving oilseeds, there have been many instances where treated seed, particularly so-called pink wheat, has been disposed of by scattering into railcars or elevators or by deliberately plugging cars. The consequences of diverting treated seed into food channels can be so serious that I feel justified in calling them to the attention of your industry, however guiltless. Known livestock injuries have resulted. Chlorinated pesticide treated seed can contaminate the finished product and may eventually end up as an illegal residue in meat, poultry, and dairy products. We have suspected, but not proven, that some dieldrin-contaminated milk episodes were caused by feeding seed directly or indirectly.

A recent newspaper article reported that two children in New Mexico were in a coma and one blinded and paralyzed from mercury poisoning. They had eaten the meat of a hog that had been fed mercury-treated seed grain.

Aflatoxin contamination. The oil refining process eliminates aflatoxins and our identified problems have been with edible nuts and feed byproducts.

It is well known that moldy peanuts are a prime source of aflatoxins. USDA and FDA have an equally well-known cooperative program to divert contaminated peanuts from consumer channels. I shall not go into it. Some slip up's do occur. Contaminated meals restricted to nonfood use have been shipped to feed mills and have been recalled. In one instance, the explanation was poor controls which did not effectively isolate "restricted" from "non-restricted" meals.

There have been seizures of domestic peanut butters and detentions of imported peanut butter. In one case no serious effort was made to remove unfit peanuts before processing even though analysis of the lot being used had shown high aflatoxin levels. Peanuts on the sorting belt were piled as high as 6 inches. In another case, peanuts with known high level of aflatoxin were deliberately mixed with good peanuts in an attempt to reduce the level in the peanut butter below detectable amounts.

In New Orleans District we have begun a limited surveillance program to analyze objective samples of cottonseed meal for aflatoxins. Our results to date have been negative. Another District, however, has encountered aflatoxins in cottonseed products from three processors over the past three years. In each instance mold was found in the conveyor system, primarily in static material from screw conveyors.

This ends the tale of "problems I have known." They involve poor plant practices which can and have caused contamination of foods for man and animals.

We have done little pesticide analytical surveillance work on the raw agricultural products or crude oils during the past few years. We have chosen to direct resources toward the processed, edible products. If I seem to be placing undue emphasis on feeds and feeding materials, it is because contaminants in feeds eventually return to man via meat, poultry, and dairy products.

Before coming here I took a quick glance at our nationwide pesticide statistics on cottonseed oil and feed products for the past two years. Out of 63 samples reported, 65 percent contained no residue, and the other 35 percent had insignificant levels. This data does not reflect analyses demonstrating pesticide chemical misuse in a plant. These are not picked up under the pesticide residue reporting system.

In New Orleans we recently completed 12 samples of cottonseed meal and 12 of soybean meal collected on a planned surveillance basis. Three or 25 percent of the cottonseed meals and 8 or 67 percent of the soybean meals contained no residues. Residues present were at insignificant levels. We hope this trend will continue.

Prevention rather than solution is the best way to deal with contamination problems. The following recommendations are trite but true:

Know the source of your oilseed. Assure yourself, if you can, that pesticide usage is in line with recommendations and applications are made by responsible persons.

Do not accept oilseed that has been spiked with pesticide-treated seed for planting. This may be impossible to do objectively since there are no provisions at this time under FIFRA or the Seed Act which require that treated seeds be distinctively colored. In 1965 FDA issued a statement of policy that any shipment of wheat, corn, oats, rice, or barley bearing a poisonous treatment in excess of a recognized tolerance, or one for which no tolerance or exemption exists, would be regarded as adulterated food unless the seeds have been denatured by the addition of a suitable color to prevent their subsequent inadvertent use for food. Some states do require coloring. Needless to say, do not engage in this practice yourselves.

In plant pest control work use only products suitable for use in food plants. Follow label directions religiously. Employ a responsible pest control operator, or if you "do your own," a person carefully trained and supervised in pesticide application.

Be very cautious in applying residual pesticides in non-food areas. Do not inadvertently contaminate food storage areas, processing machinery, and foods themselves. If you use several formulas, clean spray equipment thoroughly before reuse. This is particularly important when hazardous and persistent pesticides (like chlordane and dieldrin which might be used for termite control outside the plant) are followed by the chemicals approved for food use. The best policy is to have separate equipment for food use and to restrict it to that use.

Do not use reconditioned seed bags to package feed materials.

To prevent aflatoxin contamination, do not process moldy oilseeds. Use a commodity that has been dried to a safe moisture level and maintain it at that level during storage.

Adhere to the GMP's discussed by yesterday's speaker. Keep insects, rodent, and birds out of storage and processing areas. Reduce the need to use pesticide chemicals.

SUMMARY

by

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Thank you, Norman and members of the committee. Thank you for the honor of being asked to summarize this meeting. This was certainly a complimentary thought, but neither my knowledge nor your patience would allow me to meaningfully summarize the many excellent papers we have had presented here. Consequently, I will not attempt to do that.

However, I would like to offer a few comments on the program in general and on some of the papers. These comments will be made from the standpoint of one that's principally interested in the Cottonseed Products Business. Quite a number of these papers have dealt with oilseed other than cottonseed, but I think your interest and mine is primarily in the cottonseed.

First of all, on the subject of protein isolates for human food, it appears that at this meeting we put it all together for the first time. A few years ago we were talking about isolates primarily on a laboratory scale. At that time there were no questions from the floor as to whether glandless cottonseed had enough economic merit to assure they'd be grown and processed. I think the urgent questions typical of this meeting indicate that we have passed a milestone in this project.

The work reported by Keith Smith convincingly shows that these items no longer need be a laboratory curiosity. Everything we need to do can be done if the economic merit exists.

The food companies have told us a lot at this meeting. They have told us that there is a market for high protein food products; that the markets will grow, and that they have not only ideas but end products that will utilize protein isolates. The only thing they lack is a source of the cottonseed isolates. I think they were, in a constructive way, also telling us to "put up or shut up" about glandless cottonseed, about gossypol free protein isolates from cottonseed.

They have shown us convincingly that there are other seeds from which they can get these isolates. While cottonseed isolates do have unique and desirable properties, they can and are going ahead without us! The crushing industry can either begin to deliver these materials or it can sit back and watch product development go ahead with isolates from other oil seeds.

These companies want to see some tangible evidence that there is economic merit to the production of glandless cottonseed and to the processing of them into isolates. They want to be assured that these products will become available on a commercial scale. Otherwise, they can't afford to risk product delay or the expensive product development work necessary to develop products from cottonseed isolates. Alternative sources are at hand, and these food companies have competitors, too. If one company waits for cottonseed isolates another may take the market with soybean isolates, etc.

This tells us that the cottonseed industry, perhaps this organization, should devote some efforts — probably cooperative effort with these same food companies — to a study of the economic merit of the glandless cottonseed. The cottonseed crushing industry needs to know if the glandless seed is going to be grown. It needs to know whether isolates are going to be a big thing or a small specialty item such that one or two mills might serve the total market.

If the glandless seed does have a future, we should go to these food companies and sell them on the development of products utilizing protein isolates from cottonseed. This might best be done by pointing out the political merit of eventually working with locally grown cottonseed in many of the underdeveloped countries. One justification for this appears on the display in the back of the room which shows the coincidence of the protein deficient nations of the world and cottonseed availability. Presumably glandless seed will come to these countries of acute protein need if to any.

Many of these areas do not have soybeans or other oil seeds. The heavy capital investment required for growing soybeans efficiently will doubtless slow their introduction into many of the countries where the use of labor is an "end" as well as a "means."

Having done this, and again assuming the economic merit exists, we then must continue this industry's strong commitment to this area and we must recognize and fulfill our obligations to begin now to make at least pilot quantities of these isolates available.

I don't know the answer as to just how this should be done, but it appears necessary that it be done. If it's

going to be 6 or 8 years before we get meaningful production of glandless cottonseed, then soybean isolates are going to be 6 or 8 years further ahead. At the rate things move today, that can be an insurmountable lead and could mean that the cottonseed crushing industry will miss this product opportunity.

The situation seems much the same in our competition with soybean meal and urea for the poultry and swine feed market as reported by Garlon Harper. The cottonseed industry is going to have to come up with a superior, gossypol-safe meal or be relegated to the low-dollar markets. Otherwise, gossypol will shut us out of the poultry and swine markets and urea will haunt us in the beef and dairy industry. In both the isolate and feed markets we have to overcome the gossypol problem in order to enhance the value of cottonseed products. And we have to enhance product values if this industry is to prosper. There appears no acceptable alternative to the solution of the gossypol problem.

Now, as to cotton, Charlie Russell made an excellent presentation of the statistical picture on cotton. These Cotton Council people always do make a superb presentation. The statistics are frightening. Certainly, nobody can argue with the fact that a projection of the current trends is discouraging.

But should we simply project these trends?

Pardon me for being so optimistic, but these figures showed that in the last 10 years cotton consumption in the United States has been essentially stable. Last year happens to be the low point for that period, but this is partially due to a textile slump. It may also be a result of the runup of cotton prices in 1966. Nevertheless, domestic consumption has been in its present range for a number of years.

I think this tells us that cotton has thus far withstood tremendous competitive pressures. Rayon came along initially with a relatively low performance, expensive product; then went into high-performance rayons in which they attempted to duplicate the properties of cotton. They did, with amazing success. Then, rayon prices were reduced from about 40 cents a pound to some 25 cents because beating cotton out was tough. By doing all these things, rayon and other synthetics barely managed to keep cotton from growing in domestic consumption. They have used every innovation and resource conceivable and they haven't substantially reduced cotton's total domestic consumption. They've taken the growth but they haven't forced cotton out.

On top of this rayon competition, polyesters came along with a very high performance fiber. I don't think there is anyone here, no matter how loyal to cotton, who can argue the fact that polyester has certain performance advantages which it has imparted to blends. We might as well recognize this! But, cotton has also largely sustained this punch without giving up its volume. Even with superior easy care performance, polyester fiber prices have had to be reduced to increase market penetration. Manufacturers are offering polyester fibers at prices only marginally above that of cleaned cotton. In spite of this synthetics have still just barely kept cotton consumption from growing. You can throw in nylon, acrylics, everything you want and all combined have little more than kept cotton consumption from growing.

All you need to do is look at the stock prices and earnings reports of the big synthetic manufacturers to see that taking cotton's market is not nearly as much fun or nearly as profitable as it used to be. Perhaps this says that cotton may be faced with higher — not lower — synthetic fiber prices in the future.

The total U.S. consumption of fiber is certainly going to grow. It actually declined a little recently, but it's been growing at a rate of about one million equivalent bales of cotton consumption per year. We have the disposable and consumable fabrics appearing on the market and as they grow they are almost certain to give total fiber consumption a boost. Much of this growth is going to be wood fibers. Some will be highly engineered rayon fiber that may well pull commodity rayon out of some of cotton's existing markets leaving room for an expansion of cotton's volume. Low-priced, cellulosic, biodegradable fibers that are useful for comfort and absorbency are going to increase in volume. Cotton is such a fiber.

At today's prices I think cotton is going to begin again to participate in the growth of U.S. total fiber consumption. It won't take all the growth, but I think it's going to take some of the growth for the first time in ten years or so. If so, this tells us cotton is going to be around and I personally don't believe cotton has to sell any cheaper than it is today to do so.

Also, at today's U.S. cotton prices free world production may well be less attractive. Current world production has been stimulated by upswings in the U.S. price with short supply. With a stable supply at stable prices more of the cotton growing may be left to the U.S. as foreign countries move to increased food production.

As to the papers on manufacturing practices, pollution and sanitation which were so ably presented, suffice it to say that if this industry goes where it ought to go and where it almost has to go, these things are going to be much more important than they are even today. We can't offer isolates for food without assuring sanitation and wholesomeness.

We are caught up in a shift in national priorities and I think it's a shift that all of us are glad to see come. In our lifetimes we have seen our environment go downhill and this must be stopped.

As for flame retardance, we are about where we were 2 or 3 years ago on protein isolates. We can't know the market needs and what we are up against until standards are drawn, published, negotiated and then set up for application.

Flame retardance has tremendous potential impact for linters. It will be extremely coincidental if these standards do not shift the economics of linter fibers used in padding and bedding. We can't yet know whether these standards are ultimately going to favor polyurethane or rule it out and thereby favor cellulose. But it will be surprising if they don't significantly influence use patterns one way or the other.

In the meantime we are certainly indebted to Mr. Knoepfler and his people for keeping us within technical striking distance of these markets, telling us a way to do what we need to do whether it's the way we end up with or not.

In closing, I would like to recommend to your attention two items of literature that appear relevant. One of these is a book that's available from the California Institute of Technology. Just a couple hundred pages, paperbound, entitled, "The Next Ninety Years."

This is a publication of papers that were presented in 1967, that constitute a status report on a study that was originally made in 1957 entitled, "The Next Hundred Years." At that time a group of very learned people got together at California Institute of Technology to project what this world we live in is going to look like a hundred years hence and the problems we will face in getting there. In 1967 they decided to prepare a ten-year status report on their earlier projections. This book is the result and it reads like your clinic program. It is an excellent and interesting book. It should be required reading for all of us.

The other item is a simple quotation. "In the final analysis, it's not what we know but what we do that determines what we are." I think that's particularly relevant to this industry at this time.

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